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REPORT OF PROCEEDINGS

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OF THE

SIXTEENTH ANNUAL CONVENTION

OF THE

American Railway Master Mechanics' ASSOCIATION,

IN CONVENTION AT THE

GRAND PACIFIC HOTEL,

CHICAGO, ILL.,

June 19th, 20th and 21st, 1883.

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AMERICAN
RAILWAY MASTER MECHANICS' ASSOCIATION

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Secretary,

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Tracey.

REPORT.

The Sixteenth Annual Convention of the American Railway Master Mechanics' Association was held in the Appellate Court room in the Grand Pacific Hotel, Chicago, June 19th, 20th and 21st, 1883.

The Convention was called to order by President Reuben Wells, of Louisville, Ky., after which the Rev. F. M. Bristol offered the following prayer:

PRAYER.

Almighty and All-wise God, we thank Thee that Thou hast created man in Thine own image and given him dominion over the works of Thy hands. We thank Thee for the progress he has made in the study and utilization of the elements and forces of nature. We thank Thee for the triumphs of thought and the victories of genius. We thank Thee for all the results of the study and investigation of thoughtful men which have added prosperity to our country and glory to the age in which we live. We thank Thee, our Father, for the devotion of these thoughtful men to the interests which are so vitally connected with our national prosperity, with the good, the comfort and the happiness of the people. Teach us that Thou art the Divine Master Mechanic of the Universe. We come to Thee to ask Thy blessing on these Thy servants. Bless them in their social intercourse. Bless them in their scientific deliberations. May their stay in our city be most pleasant to them and profitable to the interests with which they are connected. May their lives and their health be precious in Thy sight. Bless their families at home, their wives and their children and the interests with which they are connected, and we pray Thee, our Father, that this meeting may result in great good to the cause that is dear to all their hearts. Bless him who is to preside in this meeting. Bless all their deliberations with wisdom, with calmness, with precision, with harmony. As these

men assemble to-day, two of their officers are missing. They have finished their work. They were faithful unto death. They have been promoted, and the names of Hayes and Fry now belong to holy memory. Bless their families. Bless their widows and children, and grant, our Father, that we may all be impressed with the thought that our days are swifter than a weaver's shuttle, and may we, as we view the fall of our comrades, day by day, apply our hearts unto wisdom. Forgive our sins. Give us clearness of knowledge and of thought. Increase our zeal in all causes of truth and of progress, and gather us at last into Thy Kingdom, where we shall know more of the great Universe of which we are a part, and we will give glory and praise to Him who hath taught us when we worship to say, "Our Father which art in Heaven, hallowed be Thy name; Thy kingdom come; Thy will be done on Earth as it is in heaven. Give us this day our daily bread, and forgive us our trespasses as we forgive them that trespass against us, and lead us not into temptation, but deliver us from evil, for Thine is the kingdom, the power and the glory, forever, Amen."

THE PRESIDENT—

Ladies and Gentlemen—I have the pleasure of introducing to you His Honor, Mayor Harrison of this City, who will address a few words to you on this occasion.

MAYOR HARRISON—

Mr. President and Gentlemen—It is part of the unwritten ordinances of Chicago that it is the duty of the Mayor to welcome every person that comes to Chicago, who can possibly bring to Chicago any good. The appropriation bill makes no appropriation to make this welcome particularly agreeable or impressive. Knowing that that could not be done, they have generally endeavored, especially for the last four years, to put a man in office who had the gift of gab and could give a good deal of wind in place of money. That is my business now. We are glad to receive you here, and hope, as the reverend gentleman has asked of Divine Will, that your deliberations may be beneficial to those for whom you work and to the world. You have come at an auspicious time. You will see here at the Exposition of Railway Appliances the machinery which you have to deal with

from its very incipiency up to its present perfection. You will see here the first locomotive that made its advent into this world in that auspicious year 1825 when I myself came upon this breathing sphere—two very auspicious events. I rather pride myself upon having been born in 1825. I pride myself upon the fact that though I have lived so few years on this planet, yet measuring my age by what has been done in the world since I came into it, I am an older man than Methuselah, who lived over nine hundred years. He but vegetated like a mussel on a rock, or like a plant in a desert place. But what have we seen since 1825? The world was then moved by ox teams, by horse teams and the fastest locomotion was that of an English stage-coach. To-day, however, we are whirled through space, at the rate, oftentimes, of seventy miles an hour. How has this change been brought about? It is because the world has possessed men like yourselves, men of genius and men of industry. It is astonishing what men can do, if they only try steadily and persistently to do a thing. Visit Barnum's circus, and observe what muscular development makes a man capable of doing. But here you see along the Lake shore what the divine science of man can do—that part which springs from Eternal Mind. There you see the capacity of brain-work to almost vie with the work of Him who rules not only this world, but countless millions of worlds. You there see the ability of brain to fix itself upon matter until it has made iron almost a living, moving and breathing thing. Gentlemen, although we have done so much since 1825, with my belief in the boundless capacity of brain, I hazard the theory that we are but on the threshold of scientific attempts and scientific possibilities. You have made engines that run speedily, but now and then the locomotives bring on a crash. You can probably by study prevent these accidents.

Again, gentlemen, I welcome you here. We will give you all that Chicago can give to make your stay pleasant, and when you depart we will wish you God-speed, and ask you to be not too long before coming to Chicago again for a future Convention. (Applause.)

THE PRESIDENT—The first business in order will be calling the roll of members.

The Secretary then called the roll, and the following members answered to their names:

LIST OF MEMBERS PRESENT.

NAME.	ROAD.	ADDRESS.
ANDERSON, H	204 Dearborn street	Chicago Ill.
ARDEN, D. D.	Central & South Western	Savannah, Ga.
BUSHNELL, R. W.	Burlington, Cedar Rapids & Northern	Cedar Rapids Iowa.
BARTON, J. C.	Hudson & Connecticut Western	Hartford, Conn.
BARNETT, J. DAVIS	Midland Railway	Port Hope, Ont. Can
BOON, J. M	Chicago & North Western	Chicago, Ill.
BLACK, JOHN	Cincinnati, Hamilton & Dayton	Lima Ohio.
BISSETT, JOHN	Chicago & Darlington	Wilmington, N. C.
BRIGHAM, L. L.	Passumpsic.	Lyndonville, Vt.
BROWNELL, F. G.	Burlington & Lamoille	Burlington Vt.
BRYAN, H. S	Chicago & Iowa	Aurora, Ill.
CUMMINGS, S. M		Boston, Mass.
CHAPMAN, N. E		Philadelphia, Pa.
COOLIDGE, G. A	Fitchburg	Charlestown, Mass.
CLARK, DAVID	Lehigh Valley	Hazleton, Pa.
COOPER, H. L.	Lake Erie & Western	Lafayette, Ind.
CUSHING, GEORGE	Northern Pacific	St. Paul, Minn.
CORY, CHAS. H	Boston, Hoosac Tunnel & Western	Saratoga, N. Y.
CLIFFORD, J. G	Illinois Midland	Paris, Ill.
COOK, ALLEN	Chicago & Eastern Illinois	Danville, Ill.
ELLIOTT, HENRY		East St. Louis, Ill.
ECKFORD, JAMES.	New York, Chicago & St. Louis	Chicago, Ill.
EASTMAN, A. G	South Eastern of Canada	Richford, Vt.
FLYNN, J. H.	Western & Atlantic	Atlanta, Ga.
FULLER, WM	New York, Pennsylvania & Ohio	Cleveland O.
FOSTER, W. A	Fitchburg	Fitchburg, Mass.
GORDON, H. D	Philadelphia, Wilmington & Baltimore	Wilmington, Del.
GORDON, JAMES	Concord	Concord, N. H.
GRAHAM, CHARLES	Delaware, Lackawanna & Western	Kingston, Pa.
GRAHAM, J. S	Lake Shore & Michigan Southern	Buffalo, N. Y.
HEWITT, JOHN	Missouri Pacific	St. Louis, Mo.
HAINES, O. A	St. Louis, Iron Mountain & Southern	Carondelet, Mo.
HODGMAN, S. A	Philadelphia, Wilmington & Baltimore	Wilmington Del.
HACKNEY, GEORGE	Atchison, Topeka & Santa Fe	Topeka, Kas.
HOWISON, N. W.	Cumberland & Penn	Mt. Savage, Md.
HENNEY, J. B	Wisconsin Central	Stevens Point, Wis.
JOHNSON, J. B	Arkansas Central	Helena, Ark.
LANNON, WM	House of Representatives	Washington, D. C.
LOSEY, JACOB	Steam Forge Co	Louisville, Ky.
LAUDER, J. N.	Mexican Central	El Paso Del Norte, Mex.
MITCHELL, A	Lehigh Valley	Wilkesbarre, Pa.
MORSE, G. F	Portland Locomotive Works	Portland, Me.
MAGLENN, JAMES	Carolina Central	Laurinburg, N. C.
McKENNA, J	Indianapolis, Peru & Chicago	Peru, Ind.
McFARLAND, JOHN	Chesapeake & Ohio	Richmond, Va.
McCRUM, J. S.	Missouri River, Fort Scott & Gulf	Kansas City, Mo.
PENDLETON M. M	Seaboard & Roanoke	Portsmouth, Va.
PERRIN, P. J	Taunton, Locomotive Works	Taunton, Mass.
PEDDLE, C. R.	Terre Haute & Indianapolis	Terre Haute, Ind.
PRESCOTT, G. H.	Terre Haute & Indianapolis	Terre Haute, Ind.

NAME.	ROAD.	ADDRESS.
PLACE, T. W	Illinois Central	Waterloo, Iowa.
PILLSBURY, AMOS	Eastern	Boston, Mass.
PURVES, T. B	Boston & Albany	East Albany, N. Y.
PORTER, J. S	Indiana, Bloomington & Western	Sandusky, O.
RICHARDS, GEORGE	Boston & Providence	Boston, Mass.
REYNOLDS, G. W	Old Colony	Taunton, Mass.
SCHLACKS, HENRY	Illinois Central	Chicago, Ill.
SMITH, W. T	Philadelphia & Erie	Erie, Pa.
SELLERS, MORRIS		Chicago, Ill.
STRODE, JAMES	Northern Central	Elmira, N. Y.
SETCHEL, J. H	Ohio & Mississippi	Cincinnati, O.
SEDGLEY, JAMES	Lake Shore & Michigan Southern	Cleveland, O.
STEARNS WM	Connecticut River	Springfield, Mass.
SANBORN, A. J		Mattoon, Ill.
SWANSTON, WM	Jeffersonville, Madison & Indianapolis	Jeffersonville, Ind.
SPRAGUE, H. N.	E. K. Porter & Co.	Pittsburgh, Pa.
SELBY, W. H.	Wabash, St. Louis & Pacific	Moberly, Mo.
SIMONDS, G. B		Sedalia, Mo.
SITTON, B. J	East Tennessee, Virginia & Georgia	Selma, Ala.
SHORT, WM. A	Canada Southern	St. Thomas, Ont.
TWOMBLY, T. B	Chicago, Rock Island & Pacific	Chicago, Ill.
TURREFF, W. F	Cleveland, Columbus, Cin'ti & Ind	Cleveland, O.
TAYLOR, J. K	Old Colony	Boston, Mass.
TOWNE, H. A		Brainerd, Minn.
THOMAS, W. H	Louisville & Nashville	Nashville, Tenn.
THUMSER, JOHN	Ohio & Mississippi	Seymour, Ind.
WILDER, F. M	New York, Lake Erie & Western	Susquehanna, Pa.
WALSH, THOMAS	Louisville & Nashville	Mt. Vernon, Ill.
WARREN, B	Indiana, Bloomington & Western	Indianapolis, Ind.
WELLS, REUBEN	Louisville & Nashville	Louisville, Ky.
WEAVER, D. L	Eastern Kentucky	Hunnewell, Ky,
WHITE, C. W	Louisville & Nashville	Birmingham, Ala.
WIGHTMAN, D. A	Pittsburgh Locomotive Works	Pittsburgh, Pa.

ASSOCIATE MEMBERS.

FORNEY M. N	Railroad Gazette	New York.
LILLY, J. O. D		Indianapolis, Ind.
LYNE, L. F.	96 Fulton street	New York.
MILES, F. B		Philadelphia, Pa.
SELLERS, COLEMAN		Philadelphia, Pa.
SMITH, WILLARD A	Railway Review	Chicago, Ill.

Secretary then read Article IV of the Constitution, reciting the qualifications for membership, and a recess of five minutes was taken to enable persons qualified and wishing to become members, to sign the Constitution.

The following names were added to the roll of members:

LIST OF NEW MEMBERS.

NAME.	ROAD.	ADDRESS.
ANDERSON, E. D.	Illinois Central	McComb City, Miss.
BLACKWELL, CHAS.	Norfolk & Western	Roanoke, Va.
BROKAW, W. I.	Denver & Rio Grande	Salt Lake City.
BROOKS, L. R.	Lima Iron Works	Birmingham, Ala.
BERRY, L. D.	Des Moines, Osceola & Southern	Osceola, Iowa.
BOTHWELL, JAMES	Chicago & North Western	Baraboo, Wis.
CAMPBELL, JOHN	Lehigh Valley	Delano, Pa.
CULLEN, JAMES	Nashville & Chattanooga	Nashville, Tenn.
CAMPBELL, E. A.	New York, Texas & Mexican	Victoria, Texas.
COLBY, GEO. H.	Boston & Albany	Boston, Mass.
CASCADDIN, R. O	Chicago, Rock Island & Pacific	Trenton, Mo.
DONALDSON, A.	Ohio & Mississippi	Vincennes, Ind.
DOWNE, GEO. W		Sydney, Australia.
DAVIS, N. L.	Rutland & Burlington	Rutland, Vt.
DOTTERER, S. H.	Delaware & Hudson Canal Co.	Carbondale, Pa.
EBLEN, JAMES	Little Rock & Fort Smith	Argenta, Ark.
EVANS, EDWARD	Cincinnati, Washington & Baltimore	Chillicothe, O.
EDDY, H. W.	Boston & Albany	Springfield, Mass.
ELLIS, MATTHWE	Chicago, St. Paul, Minneapolis & Omaha,	St. Paul, Minn.
FERGUSON, GEO. A.	Boston, Concord & Maine	Lake Village, N. H.
GATES, G. W	Western of North Carolina	Salisbury, N.C.
GILMORE, W. L.	Cleveland, Columbus, Cincinnati & Ind.,	Cleveland, O.
GEORGE, NATHAN M.	Danbury & Norwalk	Danbury, Conn.
GRIGGS, ALBERT	Providence & Worcester	Providence, R. I.
HOFECKER, W. L.	Pittsburgh & Western	Pittsburgh, Pa.
HALL, J. W	Louisville & Nashville	Montgomery, Ala.
HARDING, B. R.	Raleigh & Gaston	Raleigh, N. C.
HICKEY, JOHN	Milwaukee, Lake Shore & Western	Manitowoc, Wis.
GARRETT, H. D.	Pennsylvania Railroad	Philadelphia, Pa.
INNES, THOS. B.	115 Broadway	New York.
LOWE, GEO. W.	Chicago & North Western	Clinton, Ia.
LEEDS, PULASKI.	Louisville & Nashville	Louisville, Ky.
McFARLAND, W.	St. Paul & Duluth	St. Paul, Minn.
MILLHOLLAND, J. L.	Georges' Creek & Cumberland	Cumberland, Md.
MAST, F. M.	Louisville, Evansville & St. Louis	Evansville, Ind.
MAYNES, W. C.	Chicago & Eastern Illinois	Chicago, Ill.
MEEHAN, JAMES.	Cincinnati, New Orleans & Texas Pacific,	Ludlow, Ky.
McGRAYEL, J.	Des Moines & Fort Dodge	Grand Junction, Ia.
McCUEN, J. G.	Mexican Central	El Paso, Texas.
MIDDLETON, HARRY	St. Paul, Minnesota & Manitoba	St. Paul, Minn.
NOBLE, L. C.	Houston & Texas Central	Houston, Texas.
OLCOTT, H. P	Atchison, Topeka & Santa Fe	Deming, New Mex.
PETRIE, IRA	Jacksonville & South Eastern	Jacksonville, Ill.
POWELL, J. BERKELEY.	California Southern	National City, Cal.
RICHARDSON, E.	Shenango & Allegheny	Shenango, Pa.
RENNELL, THOMAS	Memphis & Little Rock	Argenta, Ark.
RENSHAW, W.	Illinois Central	Chicago, Ill.
RICHARDSON, R. M.	St. Louis & Iron Mountain	Little Rock, Ark.

NAME.	ROAD.	ADDRESS.
SANDMAN, C. A		East St. Louis, Ill.
STOKES, J. W.	Ohio & Mississippi	Pana, Ill.
SULLIVAN, A. W.	Illinois Central	Chicago, Ill.
SMITH, H. M.	St. Louis Bridge & Tunnel Co'.	St. Louis, Mo.
SANBORN, J. M.	Lake Shore & Michigan Southern	Norwalk, O.
SCRUTON, C. E.	Eastern & Western of Alabama	Cedartown, Ga.
TWOMBLY, F. M	Mexican Central	Chihuahua, Mexico.
TREGELLES, H.	New York, Lake Erie & Western	Salamanca, N. Y.
TANDY, H	Canadian Locomotive Works	Kingston, Ontario.
TEAL, L. A.	Sioux City & Pacific	Missouri Valley, Ia.
WATTS, A. H	Kentucky Central	Covington, Ky.
WAKEFIELD, S. W	Chicago, Rock Island & Pacific	Keokuk, Ia.
WHITE, J. F.	Illinois Central	Water Valley, Miss.
THOMAS, W. H	Louisville & Nashville	Nashville, Tenn.

Upon the Convention being called to order, the President delivered his annual address.

PRESIDENT'S ADDRESS.

Gentlemen of the American Railway Master Mechanics' Association:

At your last Annual Convention you saw proper, much to my surprise, to elect me President of your Association. Not being present at that meeting, I take this the first opportunity, of returning my thanks to the members for the flattering compliment paid me on that occasion, and I trust that I fully appreciate it as such, and that you will accept my sincere thanks and my assurance that I shall try to discharge to the best of my ability the duties devolving upon the Presiding Officer of the present Convention; and in my efforts I trust that I may have your assistance, and in matters wherein I fail, your kind indulgence.

For the sixteenth time in the history of our Association, we meet in Annual Convention, under, perhaps, more flattering circumstances than at any previous period. From a mere beginning, in less than half a century, the Railway interests have grown to their present enormous proportions. Beginning, as it were, from almost nothing, and growing and developing in that time to what we find them to-day.

Some of us began our Railway experience more than a quarter of a century ago, when the Railway was emerging, as it were, from its infancy; and the history of the Railways of this country

during this time is practically the history of our individual experience.

Sixteen years ago this Association was organized. Six persons were at the first meeting. The object was to increase our knowledge by the experience of others; to investigate various matters of interest in our business not fully understood, and give the members the results of such investigations and the benefit of each others' experience, that we might in that way serve our several Companies to better advantage and to their greater profit. To what extent we have succeeded in this during the past sixteen years, others, perhaps, are better able to judge than we. We still sometimes hear the question asked, What good has resulted to the Railway interests from the meetings of this Association? In answer to this question we may not be able to point directly to any considerable number of cases showing to what extent the Roads have been benefited, yet I am confident there are but few, if any, members who will not acknowledge their indebtedness to these meetings for many valuable ideas and suggestions brought out in reports, papers, questions discussed, and from the personal experience of members, given both in Convention and in private.

The most valuable feature, perhaps, of our meetings is that they elicit discussion, in which all sides of a question are presented; they tend to induce conservatism in ideas by showing a man that it is possible that he may be riding a comparatively worthless hobby without being aware of it; they beget caution in the matter of new devices and untried things, by evidence presented of the failure of others that at first gave equal promise of success; they cultivate and encourage that most valuable of all habits, the habit of wanting to know the why and wherefore in all cases where it is not perfectly plain—not taking it for granted that a thing is, or will result, as represented, unless a reason can be given that the idea is practicable; they encourage the observance of the rule to investigate, so far as is possible, new devices and untried plans before making practical tests—separating the chaff from the wheat. I suppose there are but few of us who can not point to numerous instances where, if this rule had been observed, the Companies making the trial would have saved both money and trouble—cases where failure was inevitable to the mind of any one of good judgment.

It seems to me that this Association has done a great deal for the Railway interests, if it had done nothing more even than encourage and cultivate the habitual spirit of inquiry, criticism and investigation in the minds of its members, the desire to investigate and know the cause of all things not well understood in the Mechanical Department under our charge. By investigations, positive knowledge is gained, and the man is able to give a reason for his conclusions.

In this address I would merely call attention to a few matters which seem to me are worthy of some further consideration:

Greater perfection in the valve motion, of late years, and the consequent use of the steam to better effect, has resulted in economy, but it is a question whether anything much further in that direction may be expected. Owing to frequent stops, the constantly varying power required, the varying speed at which the locomotive does its work, and the narrow limits of time in which these changes occur, it may be considered impossible to design a valve motion that will be entirely perfect under all these conditions, more particularly so in the case of Roads having a succession of ascending and descending grades. The "Joy Valve Gear," explained before you by the inventor, Mr. David Joy, at your last meeting, has been introduced to a limited extent in locomotives in this country, but with what success, as compared with a good link motion, I believe has not yet been fully determined. So far as the movement of the valve is concerned, the only difference seems to be that, when cutting off early in the stroke, the steam is used expansively to a slightly greater extent than occurs with the link motion, consequently, exhaust begins to that extent later in the stroke, other things being equal. Whether this feature is an advantage or a disadvantage under the conditions which a locomotive does the greater part of its work, I trust will be explained by some one able to give the facts to the Convention. In many cases better proportions in the working parts of engines, as they are called, would insure greater durability, and adapting the size and style of the engine more perfectly to suit the work to be done, would result in economy.

Competition and reduction in rates has now made the greatest possible economy in the maintenance of equipment a necessity, and

it is a question with all of us, how can further reductions be made in the cost of renewals? At present there seems to be no immediate prospect of a reduction in the cost of labor and materials, and it would seem, then, that further economy must result mainly from greater durability of the machinery and its more perfect adaptability to the amount and kind of work to be done; condition of track as to grades, speed, etc.; in other words, greater perfection in proportions where that is possible, and in the use of the best materials for the purpose; the weak parts made as substantial as the strongest; the wear of journals, bearings and sliding parts lessened by increasing the surfaces to ample proportions, and thus reducing the pressure upon a given area as low as practicable, and the wear to a minimum; making the engines as near perfect as possible, and then getting the greatest mileage that is practicable out of it in a given time, so that a less number of engines will do the work. It is cheaper to make a mileage of 60,000 miles per year with one engine than to use two in making it. The wear and tear per mile is no greater for long runs than short ones. Aside from the time required to give the engine the necessary attention, it would be cheaper, as regards cost per mile, to run it continuously, until worn so as to necessitate going into the shop for general repairs.

Among the different parts of the locomotive that seem to me should receive some notice, is the thickness of the piston in large cylinders. We began as far back as memory goes, with three inches space between follower and flange for packing rings, or packing and "dead" rings, with the ten and twelve-inch cylinders then in use, and have increased to twenty or more inches in diameter, but, as a rule, have not materially increased the surface that carries the weight of the piston. Should not this thickness be increased somewhat in proportion to diameter, in order to give the best results? seems to me a question for inquiry.

The thickness of the flanges of the larger cylinders is another point that has not kept pace with the increase in the dimensions of the other parts. If a flange one and a half inches thick was right for a ten or twelve-inch cylinder, it seems to have been taken for granted that it was also right for eighteen and twenty-inch cylinders, and the result has been that, whenever an accident happens to the cylinder the flange is generally cracked or a piece of it broken

out, often taking part of the cylinder with it. This, in most cases, would not occur if the flanges were of sufficient thickness and the matter is, in my opinion, worthy of investigation.

As regards the wear of wheels and rails, it is a question whether a wider top to the rail would not add proportionately to the durability of these parts. Within a few years we have largely increased the weight on the wheels, in some cases nearly doubled it, but have not widened the rail—the only thing that can be done to increase the point of contact—and as a consequence we find the wear of both has been increased proportionally. If the part of the tread that now projects beyond the rail could also have a bearing on the rail and carry its proportion of the load, the durability of the wheel, as regards the natural wear of its face or tread, would be increased as much, perhaps, as twenty per cent., with a proportionate increase in the durability of the rail.

The best shape for the flange and tread of the wheel, and for the inner edge of the rail, are questions about which there is much diversity of opinion among those best informed on the subject. Scarcely any two wheel manufacturers make the shape of the flange and face of the wheel precisely alike, and there is equal variation in the curve-lines of the edge of the rails, against which the flanges have their bearing.

These matters, it seems to me, are of sufficient importance to warrant a thorough investigation. We ought to know whether any improvement can be made, or whether the present variety is as good in practice as uniformity would be.

As regards diameter of the different sizes of chilled wheels in general use, there should be standards fixed for the diameter of the chills in which they are cast, so as to insure as far as possible a uniform diameter in wheels of a given size. Uniformity in pattern is very desirable, and tends to promote economy. It may be possible, however, in the case of locomotives, to attach more importance to the subject of uniformity than the results will warrant.

It would not be considered profitable to use a four-horse team to haul one-horse loads, nor good policy to use four one-horse teams to haul four-horse loads. True economy, it seems to me, requires that the machinery be perfectly adapted to its work in size and pattern. The greater the number of cars hauled per train, the less

will be the cost per car for train expenses; but if there are but few to haul at a time, the engine large enough to haul them at the required speed will be cheaper than one that is larger than necessary; but if the engine must be used for both heavy and light trains, it can not then be a question as regards the lighter trains.

The water supply of boilers is a more important matter than is generally acknowledged. To procure it free from impurities, such as adhere to the heating surfaces in the form of scale, will warrant an original outlay of a large sum of money in the saving of boiler repairs and fuel in after years.

Bad water, in the case of many Roads, results in the annual expenditure of large sums of money for repairs and fuel, that would otherwise be saved. In the case of some of them there is, perhaps, no practicable remedy, while in others a judicious expenditure of money would greatly improve the average quality of the water, and afford a large return in the reduction of repair and fuel bills.

The cost of fuel on a majority of Roads is a large proportion of the operating expenses, and how to reduce it is a serious question. Many plans and devices have been tried from time to time for reducing the consumption, but so far we have made slow progress. Intelligence and close attention on the part of enginemen and firemen is perhaps the best fuel-saver, supposing, of course, the engine to be well adapted to its work and the kind of coal used. It is a fact, however, that it is very difficult to induce the men to give this matter the requisite attention; some do well, but many are entirely indifferent to it. Could enginemen and firemen be induced to give close attention to this matter, and exercise good judgment, I believe that as much as ten per cent. of fuel could be saved, and at the same time the engines would do as much work and do it as well as at present. How to induce this attention and care is a difficult problem to solve. In matters requiring close and constant attention, the natural tendency is to soon drop back into the old and easier method. It seems to be the inevitable result.

A brake well adapted to freight engines, and a good, reliable brake for freight cars, automatic in action, in case of the train breaking in two parts, and under the control of the engineer, to apply at will and graduate as desired, is something greatly needed. A brake of this kind would enable faster time to be made; it would be the

means of greater safety from accidents, and would result in great economy in the wear of wheels, particularly on roads having numerous and heavy grades, where much damage results from wheels sliding by the use of the hand-brake. The difficulties, however, to be overcome in designing a brake perfect in action, and keeping it in good, reliable working order, are seemingly insurmountable. To derive substantial benefits from a freight train brake, its adoption must be general, otherwise the mixing of foreign cars in trains, as now, would interfere greatly, if not entirely, with its usefulness. If such a brake can be perfected, and all roads adopt it and keep it in good order on foreign cars in their possession as well as their own, it will result in great economy. Whether such a brake can be perfected, applicable to our present style of car, may be a question, but it is certainly to be desired.

It is with feelings of regret and sadness that I have to announce to you the deaths of three of our most prominent members since the meeting of the last Convention, two of whom were among my most intimate friends. These members have completed their work here, and now rest in the unseen world.

Mr. S. J. Hayes, who for nearly fifteen years to the time of his death, was Treasurer of this Association, and whom we all knew and esteemed so highly, died in this city, September 21, 1882.

Mr. John E. Martin died in Chili, South America, several months ago, but the exact date of his decease I have not learned.

Mr. Howard Fry, Second Vice-President of this Association, whose sad and untimely death occurred April 27, 1883, was personally known to almost every member. Perhaps no similar event in the history of this Association has been so generally and deeply regretted. In the prime of life, in the midst of important and unfinished projects, well filling his position, and nearing the highest point attainable in his calling, he was suddenly taken away. It seems to us a great mystery

I trust that the Association will take suitable action in regard to these deceased members, expressive of the feelings of those present at the loss we have sustained.

THE PRESIDENT—The first business in order will be the report of the Secretary. Owing to the decease of our Treasurer, I requested the Sec-

retary to act as our Treasurer until the meeting of the Association. He will, therefore, in connection with his report as Secretary also present a report as Treasurer.

The Secretary then presented his report as follows:

SECRETARY'S REPORT.

To the American Railway Master Mechanics' Association:

GENTLEMAN—For the thirteenth time it becomes my duty as well as pleasure to submit to you a detailed statement of the business of this office for the year ending with this the Sixteenth Annual Meeting.

The membership of the Association is steadily on the increase; with two exceptions all decrease has been on account of names dropped for non-payment of dues, and these have been more than balanced by new members. Robert King of Montgomery having engaged in other business has resigned and H. A. Alden has also resigned. Fifteen members have been dropped from the rolls under our rules for the non-payment of dues. Twenty-four members have joined the Association. Since our last meeting, death has again invaded our ranks and taken three of our most prominent members, Howard Fry, Second Vice-President, S. J. Hayes, Treasurer, and John E. Martin. With these changes the Association number 194 against for last year 188.

Twelve hundred copies of our last Report have been printed, two copies of which were sent to each member with the following circular:

CINCINNATI,.. 1883.

Mr...,

....*R. R.*

Dear Sir—I herewith send you our Fifteenth Report, and ask that you will have the kindness to call the attention of your Superintendent to the Secretary's Report...that he may see what contributions have been made to our support the past year, and solicit a like sum from your Company for the present year.

If agreeable, will send bill for amount, which will entitle your Road to as many copies as you may desire. An early reply will oblige

Yours Respectfully,

J. H. SETCHEL, *Secretary.*

This circular has met with a reponse in some cases exceeding the amount asked for, but as attention was not again called to the matter after being sent, in some cases it has been overlooked, and the remittances have since been promised. Where the contribution has been made, as many reports have been sent to the contributors as desired, ranging from six to fifty.

In this way 683 copies have been distributed to railroads; six single copies have been sold to outside parties, leaving a balance on hand of 511 copies.

The following are the names of the railroads, corporations, and individuals contributing to the Printing Fund:

NAME.	AMOUNT.
Pittsburgh, Cincinnati & St. Louis R. R	$10 00
Capiopa R. R.	10 00
New York & New England R. R	10 00
Hancock Inspirator Co	50 00
W. W. Evans	5 00
H. K. Porter & Co.	10 00
Boston & Providence R. R	10 00
Wilmington & Welden R. R.	15 00
Brooks' Locomotive Works.	25 00
Niles' Tool Works	10 00
Rhode Island Locomotive Works.	10 00
Atchison, Topeka & Santa Fe R. R	10 00
Louisville & Nashville R. R	10 00
Illinois Central R. R	10 00
Lehigh Valley R. R.	10 00
J. H. Raymond.	10 00
Terre Haute & Indianapolis R. R.	10 00
Kansas City, Fort Scott & Gulf R. R	10 00
Chicago, Rock Island & Pacific R. R	10 00
Lake Shore & Michigan Southern R. R	10 00
Pittsburgh Locomotive Works	15 00
Delaware, Lackawanna & Western R. R	10 00
Missouri Pacific R. R	10 00
Baldwin Locomotive Works	20 00
L. B. Flanders' Machine Co	10 00
Rogers' Locomotive Works.	50 00
Hinkley Locomotive Works	8 75
Schenectady Locomotive Works	10 00
Jeffersonville, Madison & Indianapolis R. R.	10 00
Connecticut River R. R	5 00
Fitchburgh R. R.	10 00
New York, Lake Erie & Western R. R	10 00
Mobile & Ohio R. R	10 00
Cincinnati, Cleveland, Columbus & Indianapolis R. R	10 00
Portland Locomotive Works.	10 00
Ohio & Mississippi R. R	10 00
Total	$463 75

October 11th I received notice from our President to receive and receipt for all moneys and paid bills belonging to the Association from the estate of our late Treasurer, and act as Treasurer until our next Annual Meeting. A statement of account is herewith inclosed and included. By referring to our Treasurer's last report it will be seen that the cash balance on hand June 19, 1882, was $514.22, and commencing with that amount and adding thereto the receipts from all sources during the year as follows, we have the total amount to be accounted for at this date:

Balance on hand June 19, 1882	$514 22
Amount received by Assessment	778 00
Amount received for Printing Fund	463 75
Amount, cash, for Reports sold	19 07
Total amount to be accounted for	$1,775 04

The following is an account of disbursements made, for all of which I hold receipted approved vouchers, which are herewith submitted:

Voucher No. 1—Amount of salary to Secretary	$600 00
" " 2—Amount on Reporter's bill	20 00
" " 3—Amount Balance Reporter's bill	75 50
" " 4—Amount Railroad Gazette	10 00
" " 5— " "	56 62
" " 6—Amount Wilstach, Baldwin & Co	622 70
" " 7—Amount of bill for postage	70 60
" " 8—Amount Cincinnati Safe Deposit Company for box rent	15 00
Total	$1,470 42

Which amount deducted from the total amount to be accounted for, leaves a balance on hand, at this report, of $304.62.

BOSTON FUND.

In this connection the following correspondence is interesting, and is submitted for your information:

NEW YORK, 28th *June*, 1882.

J. H. SETCHEL, ESQ., *Secretary American Railway Master Mechanics' Association:*

Dear Sir—Enclosed I have the pleasure to hand you check for eight hundred and thirty-five dollars and thirty-five cents ($835.35), payable to the order of Samuel J. Hayes, Treasurer of your Association.

This check is the amount of the balance remaining in hand of the

Entertainment Fund, the same being subscribed by the friends and well-wishers of your Association, and it is now passed over to your Treasurer, in aid of what is known as your Building Fund.

I am, sir, yours very respectfully,

[Signed] WILLIAM TOOTHE,

Treasurer of Entertainment Committee.

This was forwarded to the Treasurer and the President, and Supervisory Committee notified of its receipt. The draft was endorsed back to the Secretary, with the following note:

CHICAGO, *July* 5, 1882.

J. H. SETCHEL, ESQ., *Secretary:*

My Dear Sir—I received yours of the 30th inst., inclosing check from William Toothe for $835.35, which I endorse back to you with my *vote* to invest it, together with what you have on hand, in Government bonds. My vote, with the President and yourself, will make a majority of the Committee. My health is very poor, but I am sure I will come out right, soon.

Yours very truly,

S. J. HAYES, *Treasurer.*

This letter was at once communicated to President Wells, and September 20th the President and Secretary met at the bank, and with the contribution and previous uninvested principal, purchased a one one thousand, and one one hundred bond, paying therefor $1,324.93, leaving a remainder of uninvested interest $64.93. The following is statement in detail of the fund at this time:

Uninvested interest September 20, 1882	$64 93
October, 1882, interest on $4,800	48 00
January, 1883, " "	48 00
April, 1883, " "	48 00
Total interest unapplied	$208 93
Amount principal	4,800 00
Total value of fund	$5,008 93

Yours very respectfully,

J. H. SETCHEL,

June 19, 1883. *Secretary and Acting Treasurer.*

The reports of Secretary and Treasurer were accepted.

On motion, the President appointed as Auditing Committee: J. M. Boon, J. H. Flynn, and George Hackney.

THE PRESIDENT—The first committee on our list is the Committee of Research on Improvement in Boiler Construction. I understand that

the Chairman of that Committee will not be here until to-morrow, and, if there is no objections, we will pass that until then.

The next Committee is on New Plans of Construction and Improvement in Locomotive Engines.

THE SECRETARY—This paper is a paper prepared by Mr. Dean, one of our associate members, who, you remember, was elected last year, and the subject is the same as that which the President announced, but there is no report from the Committee. You will please notice that it is full of suggestions, which I think it would be well for the members to note down as the paper is being read, and they will be in a better position to discuss them after the reading is finished.

The paper was then read and received.

IMPROVEMENTS IN LOCOMOTIVES WITH REFERENCE TO EFFICIENCY AND STYLE OF FINISH.

Gentlemen of the American Railway Master Mechanics' Association :

Within the last five years the locomotive engine has received more attention, probably, than it had before since the time of its most rapid evolution, that is to say, since the time when the problem to be solved was to make a locomotive that would furnish steam for moderately fast and heavy traffic, and that would be certain enough in all particulars to make the conduct of a very important business sure. The locomotive has always been a uniquely fascinating machine to nearly all persons, from boyhood up, probably because it is a fast traveler, being more or less associated with swift animals. This regard has, indeed, caused locomotives to be considered with more or less superstition, and we see them bearing the most extraordinary names, painted in the most inappropriate manner, and being the subjects of wonderful tales. The question of appearance often caused design to be sacrificed to it, and even to this day there are many locomotives running which indicate that there is not only some of the feeling referred to existing, but that the designers are not well versed in first rate principles of machine design and constructive mechanical engineering. At least one road in this country can be pointed out on which many parts are fastened together with stud and tap bolts put in, in the most invisible and inaccessible places, giving the engine the appearance of being, to some extent, glued together. Not only this, but the amount of bright finish on the engines is absurdly great. Now, I think that most of you will

agree with me that this is all wrong. Nothing of the sort will be found on a Sellers, Bement, or Whitworth machine, and it would be difficult to say why a locomotive should be differently treated.

Some of the principles which should be kept in view in designing a locomotive are simplicity, directness, convenience in manufacturing, inspecting and repairing. A locomotive or other machine should be as smooth and free from projections of all sorts as possible, so long as these features are not inconsistent with the efficiency of the machine. In particular, all nuts and other parts should be conveniently placed, and no attempt should be made to conceal anything, for the minute this is done there enters what may be aptly termed mechanical immorality. The means which we employ to fasten parts together are the best we have, and should be honestly used. The beauty of a machine consists largely in the propriety of the design, and any departure from propriety is a caricature.

The writer believes that sand boxes and dome covers should be perfectly smooth and without mouldings. They should have hemispherical tops, and should flare out to join the boiler. In this particular Mr. Ely, the late Howard Fry, and Mr. Lander have set good examples.

The forms of cylinder casing should receive more attention. This should be entirely without mouldings, should have flat ends, and the parts joined should be flush with each other. It would be well to consider whether, for the sake of simplicity, at least, cylinder heads without casings cannot be used with advantage more than they are at present. If they were used in conjunction with solid web pistons, which will be noticed farther on, they could be made hollow, thus giving an air space for the non-conduction of heat. The objections to this construction are the cost of founding and the weight. On the other hand the gain in strength due to this form, when the two webs are connected by ribs, may be an important advantage with the increasing steam pressures which are sure to follow the few leading instances of it which we now have.

Occasionally we hear of the burning of locomotive cabs. In England and on the Continent of Europe, as most of us know, iron is always used for cabs of a thickness of about 3-16 inch. The roof is sometimes made of wood, easily detachable from the

sides and front, and is covered with some waterproof material. This overcomes the objection that an iron cab would be noisy in rainy weather, but the objection that it would be cold in winter and hot in summer may have considerable force. The weight of an iron cab would be an advantage in these days.

Having considered thus far matters relating mostly to the appearance of locomotives, I propose to treat in same detail certain parts of the American locomotive in order to see whether some improvement cannot be made in their efficiency. The American locomotive is a remarkably wasteful machine both in the use of the fuel and the use of the steam after it is generated. It is to be regretted that we have few if any records of a first rate series of experiments to show just what our best locomotives are doing, and it is to be hoped that some of our leading railroad companies will soon employ thoroughly competent experts to make experiments on the matter. That there is room for improvement no one will doubt. There are locomotives burning as much as 95 pounds, and even more, of coal per square foot of grate area per hour, which is undoubtedly a very wasteful rate. To show how economical a locomotive can be, the writer has some figures which were furnished to him by Mr. Patrick Stirling, Locomotive Superintendent of the Great Northern Railway of England, giving the results of a series of experiments made by him with one of his 8 feet 1 inch single pair of driving wheel locomotives, having cylinders 18 by 28 inches. These experiments were undertaken for Mr. Wright, Chief Engineer of the British Navy, when the introduction of locomotive boilers into the English Navy for torpedo boats was contemplated. They extended over a period of a month, and were doing ordinary working. The following is an abstract of the results:

Distance traveled daily	152 miles.
Weight of train, tender and engine	213 tons.
Average speed per hour	50 miles.
Fuel used per mile, including getting up steam	28 lbs.
Fuel per indicated horse power per hour	2.05 lbs.
Pounds of water evaporated per pound of coal	9.88 "
Steam pressure per square inch	140 "

Comparing some of these figures with similar ones in this country there is a striking difference. The following seem to be repre-

sentative in this country for a train of, say 350 tons, including the locomotive and tender, viz.:

Average speed per hour.	35 miles.
Fuel per mile	50 lbs.
Fuel per indicated horse power per hour	$4\frac{1}{2}$ lbs.
Pounds of water evaporated per pound of fuel	6 to 7 lbs.
Pounds of coal burnt per square foot of grate area, per hour .	110 lbs.

The last three figures show an enormous waste of fuel in our locomotives, while those of the English engine show a performance nearly equal to the best stationary practice.

In seeking the cause of the great consumption of fuel in our locomotives, we must recognize the fact that they are pushed frequently to their utmost capacity, and it is evident that the tremendous rapidity with which the combustion takes place is chiefly responsible for it. In stationary practice a consumption of more than 40 pounds of coal per square foot of grate area per hour is unusual, while in locomotives as much as 130 pounds is sometimes burnt. The chief cure for this evil is an increase of grate area, and this can be accomplished (while keeping the fire box between the axles) by using a plate frame $1\frac{1}{8}$ inch thick, and the Joy Valve Gear, which allows the fire-box to be brought up close to the forward driving axle. In this way the width of a fire-box can be increased $5\frac{3}{4}$ inches over the usual width with bar frames, and the length can be made 84 inches, giving a grate 84 by 41 inches, the area of which is 23.9 square feet against 17.6 square feet, the amount usually found in locomotives with their driving axle centers 8 feet 6 inches apart. This is a gain of 6.3 square feet, or almost 36 per cent. If, now, an engine with the smaller grate area should burn 100 pounds of coal per square foot of grate area per hour, a similar engine with the larger grate area, but burning the same total amount of fuel, would burn only about 75 pounds per foot of grate. The consequence of this slower rate of combustion would be that a larger exhaust nozzle could be used, less coal could be pulled through the tubes, fewer sparks would be sent out of the chimney, there would be less back pressure in the cylinders, and a considerable gain in economy would result.

The recent extensions of smoke boxes to catch cinders seem to be a decided improvement, but this is attacking the problem at the

wrong end. The combination of the deflector and brick arch are undoubtedly very efficient in promoting complete combustion and in retaining the particles of coal in the fire-box, which would otherwise be taken along by the strong draught.

It appears to be a fact that enough air to support combustion cannot be admitted through the grate, and therefore it is advisable to run with the furnace door a little open in order to supply the deficiency. This air should be spread outward in all directions by the deflector to meet the gasses which are thrown forward by the arch. In order that this process may be most perfectly carried out, the door should have the hinges at the bottom, and it should open at the top; or if it opens at the side, which is more convenient, it should be in two parts, the upper part being hinged to the lower, and capable of turning back under control of a latch. In this way a thin film of air can be admitted, and both sides of the fire treated alike.

Great difficulty has been experienced in the maintenance of deflectors on account of their rapidly burning out. The writer, however, believes that this can be completely overcome, if not by fire-brick resting on water-tubes, as described by Mr. Fry last year, by a water-space deflector, either cast whole (as steel castings are now-a-days excellent) or made of boiler plate. The water-space could be made of any thickness, and circulation could be maintained by connecting the lower part of it by means of pipes to the coolest part of the fire-box water-space, and the upper part to the crown sheet. From experience on the Old Colony Railroad with steel water-space arches in place of brick arches, it may be anticipated that a deflector made as described, if provided with mud-plugs, would remain good an indefinite time.

The preceding considerations lead to the belief that there is ample opportunity to improve the American type of passenger locomotive, and that the advent of a departure from it is not necessarily near.

The frames of American locomotives not only cause the fire-box to be very narrow, but they have the disadvantage also of not possessing sufficient vertical stiffness to enable them to stand alone. They, in consequence, require somewhat rigid connection with the boiler, and cause it considerable harm as it expands and contracts.

The only rigid, or approximately rigid, connection between the boiler and frame should be at the smoke-box, and the boiler should simply rest on the frames between the driving wheels. The frame then becomes the pushing and pulling part of the machine, and the boiler is carried along only for the purpose of generating steam and giving weight, and is allowed perfect freedom to choose its position on the frame. This frame can be wholly made of 1 inch or 1⅛ inch plate, as in England, or it can be made of plate between the driving wheels, and a bar 2 inch or 2½ inch by 8 or 10 inch forward of the driving wheels, or, in fact, it might be, in the latter part, of channel, or T-iron. The T, or channel form, would be inconvenient, however, for the attachment of parts. Lateral stiffness can be effectively given to these thin frames by cross-bracing.

Much has been written in late years concerning the proper construction of boilers, and but little will be said here on this subject. The following are laid down, with brief argument, as general specifications of a first-class locomotive boiler:

1. Use butt joints, with inside and outside covering plates, the circumferential covering plates being continuous welded hoops.

2. Punch the holes ⅛ inch small and ream them to size when the plates are in place, or drill them in place. In either case counter-sink the holes slightly in order to give a fillet to the rivet head.

3. Rivet by machinery, preferably by the hydraulic system.

4. Place the screwed stays farther apart than usual, and cup their ends with a button sett.

5. Use a straight boiler with a Belpaire fire-box, as this form can be perfectly stayed.

6. Incline the fire-box tube sheet toward the furnace door, in order to give a wide water space and to allow the steam to escape easily.

7. Avoid over-hang in the side plates of the inside fire-box, and instead of this, incline them inward, securing a large number of tubes by flanging out the side sheets forward so as to join a wide tube plate. This is important because an over-hung plate forms an ineffective evaporating surface, and impedes circulation.

8. Make the ash-pan strong and as tight as possible, in order that when running without making steam, it may be closed to prevent

combustion, thus doing away with the necessity of opening the furnace door and allowing cold air to blow on the plates.

9. Place the tubes in rows making 30° with a horizontal line rather than 60°, as the circulation is less impeded in the former, while nearly the same number of tubes can be got in as in the latter.

10. If the water is of good quality take it into the boiler by a pipe passing through the end of the boiler, and run the pipe so far forward that the water will be nearly or quite as hot as the steam before it is allowed to spread about.

11. Use no dome, but rather take steam through a perforated pipe, as it is dryer than dome steam, and the boiler is less likely to prime, while domes are a source of weakness and expense.

The writer is aware that the latter condition is opposed to the settled principles of most American practice, but he believes that the matter has not received the attention which it deserves. In England and on the Continent of Europe many domeless locomotives are in use; for example, on the Great Northern Railway there are 750, on the Glasgow and South Western 280, and on the South Eastern 55 per cent. of the total number are domeless, and old locomotives are being converted as rapidly as possible.

It is generally assumed in this country that engines with domes work dryer steam and prime less than domeless engines; but the writer believes that these are mistakes, for, in the case of domed engines, where does steam get rid of its moisture? where does superheating take place? and is not steam in the dome farther from the hottest part of the boiler than steam in the top of the boiler? Furthermore, is not steam rapidly rushing to one point more likely to entrain water than steam passing quietly through holes in a pipe which extends the whole length of the boiler, the perforations ending 3 feet from each end? The steam capacity of a dome is of no advantage as a domeful of steam is an insignificant quantity.

In addition to the possible changes in locomotives thus far mentioned, it is desirable to direct the attention of the members of the Association to some matters of smaller detail. For example, the ordinary coupling rod, connecting rod, cross-head and guide are not what they should be. A drawing of an improved form of connecting rod is herewith presented. Coupling rods with bushed eye ends are simple, cannot be tampered with, are beautiful to

look at, and have been known to run three years without renewal.

The 4-bar guide which is so common, is weak, expensive, and is perfectly exposed to dust. This should give way to some other form; for example a cast iron bored guide cast solid, with the back cylinder head. This is the most perfect form of guide and cross-head yet devised, because, among other things, the cylinder head can be turned in the machine which bores the guide, and at the same time, thus insuring perfect alignment. When the opposite driving wheels are at different levels, it will allow the cross-head and piston to revolve, thus doing away with twisting the connecting rod, wear on the edge of the guide bars, and grooving of the bars and cylinders. Moreover, it allows the upper bearing guide surface, on which nearly all the wear takes place, to be wider than the lower, and it can be boxed in and protected from the dust. In a word, it posseses very valuable features.

Breakages of rock shafts now and then occur, and the question arises whether it would not be an improvement to make them of gun iron or steel castings, larger in diameter than usual and hollow. In this way a better casting would be probable, and the metal would be better distributed, weight for weight, than in the ordinary form.

Solid pistons have the advantage of simplicity and cheapness. As they are almost exclusively used in England it would seem that they would be successful here if understood.

This Association has for a long time considered the matter of the best form and material for coupling rods with somewhat satisfactory results. A rod made of solid drawn weldless steel tube would possess excellent qualities for this purpose. It would be strong, light, elastic and reasonably cheap. If one of these tubes 3½ in. outside diameter, and ½ in. thick be passed between rolls and flattened to a thickness of 2 in. and then welded to solid eye ends, it would make a good rod, provided the welding could be well done. This rod would have a depth of about 4⅜ in. and if 8 ft. 6 in. long the stroke being 24 in. would have a factor of safety of 3¾ in. when making 300 revolutions per minute, against 4½ in. for the heaviest I-form used. This is rather small but probably larger than that of many rods in use. The writer regrets to say that he is unable to find out the elastic limit, ultimate strength, elongation, and contraction of area

THE PRESIDENT—It has been our custom heretofore, by resolution of this Convention, passed several years ago, to appropriate the hour from twelve to one for the reception and discussion of questions which may be presented by the members, and, according to that resolution, questions of this character are now in order. Any member who has any question which he wishes to present will please hand them to the Secretary.

SECRETARY—There is one, which is presented by Mr. Sprague. "Which is preferable, hot or cold water pressure, for testing boilers?"

MR. H. N. SPRAGUE, E. K. Porter & Co.—For several years I had been testing boilers with hot water, and in my ignorance I thought I was doing the best thing I could; but the question has been raised once or twice with me lately, by parties, as to whether hot water was better or as good as cold water, and I wished to see whether there was not some one, perhaps, more scientific than myself who could help me. My idea has always been that the way to test anything was under the conditions in which it was expected to work, and that a boiler expanded by hot water would receive the strains under similar conditions to those of practice; and possibly the construction of the boiler might be such that it was weaker under expansion than it was when cold, and if so, that was certainly the proper way to test it. So far as I can judge, having no scientific knowledge of the matter, I cannot see any reason why hot water pressure is not the best; but I would like to know if anybody has a contrary opinion.

MR. N. W. HOWISON, Cumberland & Pennsylvania Railway—I would ask the gentleman whether he is speaking of applying the hot water to old boilers or to new boilers?

MR. SPRAGUE—As a rule I have occasion for testing new boilers only, but I can hardly see the difference in this respect between a new and an old one. I might say further that I understand the Government practice is to test with cold water pressure, and that, I suppose, is what raised the question of the comparative advantages of the two methods. I cannot conceive any reason why hot water is not better than cold, and I want to find out if anybody can.

MR. HOWISON—I have tested boilers, cold, at the Woolwich Arsenal, for the English Government, and on my own road I test them with warm water. I don't generate any steam at all, and very seldom use a pump. I fill my boilers very full with water, and make a light fire in the furnace, and by the expansion that way I get any required pressures. If I have any doubts about a boiler, I go inside and examine it and find out its condition as well as I possibly can, and then test the boiler by the expansion of the water.

Mr. Sprague—It is cheaper with us to test with hot water. That is one thing that led me to adopt it in the first place. We have a compound injector with which we fill the boiler, which heats the water and then runs it up to any pressure desired, usually testing at from 180 to 200 pounds hot water pressure.

Mr. Lewis F. Lyne, American Machinist—The gentleman who proposes the question has asked for information in reference to the using of new boilers or old boilers by the hydrostatic pressure. He seems to be under the impression that it doesn't make much difference whether they test a new boiler or an old boiler by the hydrostatic pressures. I have been brought into contact somewhat with the Government officials in testing boilers, and I do not agree with them that the hydrostatic test is a proper test for boilers, especially old boilers. It proves but one thing—simply that the boiler is tight. It does not prove that the braces are properly placed; it does not prove that things are in order inside the boiler; it does not show whether or not there is any weakness; it does not show that the boiler changes its form under the pressure. The Hartford Steam Boiler Inspection and Insurance Company, who have spent a great deal of time on this subject, do not apply the hydrostatic test unless they are requested to do so. They rather rely on a thorough inspection of the boiler inside and outside, and what they call the hammer test; that is, examining each part of the boiler by striking it with a hammer. This test reveals any weakness in the way of blisters or corrosion by knocking off the scale. So I think that the hydrostatic test, applied to a boiler, does not prove that the boiler is entirely safe, and if applied to an old boiler that is crystallized, such a test will often render that boiler dangerous, whereas, otherwise, it would be entirely safe; and, indeed, I have known old boilers to be tested and injured greatly by such test.

In reference to using hot or cold water, I believe that hot water is preferable, because the strength of the iron increases as the temperature rises, up to about 520°, at which point it is probably the strongest. From that point it begins to weaken; so I should say that hot water is preferable to cold water for testing boilers; but the hydrostatic test should not be relied upon as conclusive, but in all cases a thorough examination inside and outside should be made.

The President—If there is nothing further on that subject, and no other questions, we will resume the regular order of business.

On motion, a recess of ten minutes was taken.

THE PRESIDENT—The Convention will come to order. The paper presented by Mr. Dean, which you have heard read, is before the Convention for discussion.

MR. J. H. SETCHEL, Ohio & Mississippi Railroad—There seems to be a good many points in this paper, some that I endorse, and there are others that I do not; and I should dislike very much to have this paper go into our reports as the sense of this Convention unless it really is so. Mr. Dean is a young man who has never had much experience, and I think his theories are of English extraction. Some of them are excellent, and others differ very much from our practice, and I think his ideas are not correct. I have jotted down several things that I will notice.

He speaks of iron cabs. Now, I don't know, really what advantage an iron cab can have in any way. I understand, from his paper, that he suggests it to be an advantage on account of its weight. An iron cab of 3-16 of an inch thickness is going to be much lighter than the ordinary wooden cab. It seems to me that an iron cab, in case of a collision, or in case the cab is knocked off by the rods, or anything of that kind, is much more dangerous than any wooden cab. It is customary on some roads, I think—notably the Pennsylvania Central—to place a very heavy plate under the cab, of half an inch, or five-eighths of an inch in thickness, to protect the engineer from flying rods, but that is so heavy that it is hardly possible to knock it to pieces; but a thin sheet of iron I think would be liable to endanger the engineer much more than wood.

Mr. Dean charges that the American type of engine is a very wasteful one. Well, now, I don't understand from that whether he means more so than it ought to be, in comparison with other engines, or whether it is so because of its American design. I believe that in England they are much more careful of their fuel than we are in this country. Mr. Joy, you will remember, at our last meeting, said that it was almost impossible to get up any device whatever that would make a saving of fuel in England, from the simple fact that they are so careful of the fuel that they save all they possibly can, anyway. Now, if I am correctly informed, a fireman who makes smoke in the streets of any English town is liable to be brought before a magistrate, while in our country the fireman's practice is to keep the black smoke going all the time. As soon as the smoke begins to whiten it is an indication to them that more coal is wanted, and they throw in more. For that reason we burn much more coal than we ought to, on account of the slovenly way in which we fire our engines, and not on account of their construction. The Cincinnati Southern, for instance, is a road upon which, heretofore,

very little attention had been paid to fuel. The rule was to keep the black smoke rolling all the time. By adopting the extended front, and by disciplining the firemen, they have apparently made a saving of 25 to 33 per cent. in fuel. Now, I don't think it is the extension of the front end that saves that amount of fuel. I don't believe that the best device of that kind really is a saving of fuel, but it is simply the care that is given in firing that saves it. With the extended front end it is impossible for the fireman to get steam unless he carries a light fire. He has got to keep his fire down until the light exhaust can get hold of it, or else the engine will stall, and instead of firing heavy when the steam goes down, he soon learns to fire light.

I think that another thing that has a bearing on this point is the fact that American engines are pushed to their utmost. I think our engines do more work here. We haul more tons for the same sized engine than they do in the old country. It is not because our engines are not as good, but because we require more of them.

I speak of these points because they are to me of great interest, and if there is any information to be gained, now is the time.

You will notice, too, that Mr. Dean's paper advocates opening the furnace doors while running. Now that seems to me entirely wrong. The trouble with most engineers is to keep the doors shut. There are but very few engines that can be fired with the door open. The fireman that gets the door shut the quickest after the fuel is introduced always succeeds in getting most steam. To design an engine that will run with the door open we would require a very large boiler and a better generator of steam than I have ever seen on any of our railroads. Further along you will notice, in Mr. Dean's paper, he incidentally brings out the idea that it is very damaging to the sheets to have the door open, which is undoubtedly the fact, and I would not want any one to think that this Association advocated running an engine with the door open, with the air admitted away above the fire, where it could do no possible good. If you are going to introduce air, you want it down where the gas is of a temperature that it will ignite and be of some service.

Another thing in this connection which I ought to mention here is the subject of deflectors. He notes that steel deflectors have been in use, and thinks they may be made very durable. Now, I believe it is the experience of all our Western men that the water deflector is a failure. There are a number of master mechanics here who have tried it, and have had to take it out simply because it could not be kept in. It would crack and burn out, and, as a substitute, they have put in the brick arch, and going back from the brick arch to the water-table it seems to me would be retracing our steps. It may be right, but I don't think so.

Mr. Dean speaks of one thing that is very interesting, which is neglected in our American engines, and that is the conditions of the frame. I do not agree with him that a slab frame is the best, and yet, perhaps, in order to increase our grate surface it is better to sacrifice opinions. We all know that Mr. Eddy, of the Boston and Albany Railroad, for years has been using what he calls a slab frame, and thereby getting wider fire-box, and it is possible that it may be desirable to do that. But there is one thing certain—that almost all our engine frames have not enough of depth to support themselves as they ought to be supported, and to obviate that, most builders put on heavy braces to the boiler, which is all wrong. The only rigid connection with the boiler, as Mr. Dean says, ought to be to the cylinder, and then the boiler should be left free to expand, and choose its own position on the frames, and then the frames should be braced laterally, so that they are sufficient to do their work. Bracing our boilers the whole length of them to the frame is certainly a great mistake.

In regard to stay-bolts, Mr. Dean suggests that they be placed further apart and capped. I believe it is the practice of most all builders to rivet over and cap their stay-bolts, and I think that the most of us put them quite far enough apart. If anything, we want to put them nearer together.

There is another matter about which I do not feel very well posted, but it seems to me clear that the suggestion of a perforated pipe is all wrong. I know that there is some force to the hint that a dome full of steam is of no value, but if we can keep a dome full of steam ahead all the time it seems to me that we can get dryer steam than we can possibly through a perforated pipe. It is higher; it is not subject to the action of the water as it would be in a pipe, which must pass over it back and forth to some extent, and is not liable to entrain the water.

In what he says about guide-bars, I agree with him to some extent that our top bars ought to be heavy and wider. Some of our locomotive builders are adopting that practice. The Louisville & Nashville, on their standard engine, have a guide that extends the whole width.

In regard to solid pistons, it seems to me if there could be a solid piston and piston-head gotten up it would be a movement in the right direction.

I think there are a great many good things in this paper that it would be well for us to look to and possibly adopt, and I think there are some other things that are wrong, and these ought to be scanned carefully and the error pointed out.

Mr. Sprague—Mr. President, I wish to record my objections to leaving the mouldings off the domes and sand-boxes. I don't know why we

should. I think we should consult looks a little in locomotives as well as in houses. The fact of the symmetrical lines and mouldings of our engines may be what causes us to prefer them to the English engines. It reminds me of a remark a master mechanic made in the Centennial Exposition, while looking at the Reading engine, which is supposed to be a very plain engine. He said: "I don't see the object in trying to make it look as ugly as possible." It is well enough to ornament a little. I think when we come to leave off the mouldings from our sand-boxes and such things as that, it will not be pleasing, and I repeat I don't know why we should not cultivate looks to a certain extent, as long as it costs but a trifle, as well in a locomotive as in any other kind of machinery or building.

Mr. Smith—I think Mr. Setchel takes a wrong view of running with the door open. Our custom is to put one shovelful of coal in the firebox, and open the door one notch, which is about half an inch. We use the deflector, and by that means, introduce a thin stream of air over the fire, which prevents smoke.

Mr. Gordon—Mr. President, I should say that we have just fitted up a set of heavy cross-head guides in our shop, and I am very sorry I did not keep a record of the actual expense. When I talked with our foreman in regard to the expense of the guides, he informed me that it was about four times as much as that of the ordinary guide. I cannot say anything in regard to the working of it as yet. The engine has made only three trips, and those light. The engine came out of the shop last Tuesday. I have no doubt but that the guide will be a very good working guide. He gets a very strong cross-head, and a very good wearing surface, but the expense of fitting them up must exceed that of the ordinary guide, I think, certainly 50 per cent. As to covering them up, I think that might be an advantage, but I think we get a good share of our dirt from underneath, and that, of course, is not covered. I think it would, perhaps, be better to have the guide where the engineer could see it. I was particular to have the cross-head fitted very loose, but still it is expensive; for instance: there are eight bolts, with which we bolt on these brackets on the side. They are ten inches through, and the bolts are all turned and fitted nicely, which adds a good deal to the expense.

Mr. J. Davis Barnett, Grand Trunk Railway—Mr. President, if it is supposed, from the statement made in Mr. Dean's paper, that a large proportion of the engines built in England are domeless, and take their steam through a perforated steam pipe, all I can say is, that that is a wrong impression. There is no tendency, so far as I can see, on any of those large railways, to go back to the practice of thirty years ago, when

Hawthorne introduced the perforated pipe. In the case of the cabs, if it is supposed that the practice there is to make the cabs of three-sixteenth iron, that is an error. They use a wooden roof, and the insides are of one-sixteenth iron. If I understand Mr. Dean right in the matter of ornamenting our engines, it is not that he objects to beauty, but he thinks that beauty can be attained by simple curves, rather than with the use of involved mouldings. I think he wishes us to get a nice looking engine, but that we should attain it by simple sweeps, rather than with the very involved mouldings we sometimes use on our sand-boxes and domes.

In one part of the papers it is stated that Joy's valve-gear has been adopted in England, on the Great Western Railway, the London & North-western, and others, and the inference is, I suppose, that these railways are extensively using this gear. I may say that the Great Western has it on one engine only, and that one not in every day use. The London & North-western has it on two engines, and ten are in construction with it. So that yet it is in the experimental stage with these large railways.

MR. J. K. TAYLOR—Mr. President, there were some engines on the road with which I am now connected, that had the Jarrett water table. Those engines were good steamers, but the trouble was to keep them tight. There was another serious defect in regard to the fuel we put into these engines. After it passed over the water deflector, it would invariably fill up between the deflector and tubes. I suggested to the boiler maker to make another deflector, and put it in there, and cut it away from the flue sheet, so as to let all the dirt pass down, and let the flame have a chance to pass up between the deflector and flue sheet. That was tried, on two or three engines, and I invariably got a good result from it; but I admit I could not put those tables in and maintain them, if I had the same kind of water to use that we have in the western country. They would invariably fill up with mud, and they would be leaking all the time. I have on our road now, some twenty of these deflectors, and you cannot find one engine that has ever had a rivet burnt out on them, or a crack on the sheet, except where there was a mechanical defect. I saw at once that the form of the deflector had to be made differently, so that there could be no point where the flame should become staggered, then by inverting the arch, I remedied all defects. I found the heating surface in the water table as good as any heating surface in the boiler, and I never found a spoonful of mud or scale collected in them. I found no trouble in putting them in, and it increases the efficiency of the engine in making steam very much. Mr. Dean referred to it. He had ridden on engines I built, very frequently. Probably his

noticing the way those engines steamed, was what lead him to make the assertion found in his paper. I think, in any part of the country where you have good water, they can be maintained, but I wouldn't attempt it if I got such water as you get here.

MR. SMITH—I would like to ask the gentleman if he considers the water table any more economical than the brick arch.

MR. TAYLOR—I think it is I think fifteen feet of good heating surface for making steam is a good deal better than a chunk of brick.

MR. SMITH—I think there is ten per cent. economy in the brick arch.

MR. TAYLOR—Yes, sir, I will admit there is economy in using the brick arch, for forming a better fire, and burning your coal, but we get as good results from using the water table, as with the brick arch, from the fact that the fire has got to pass over and down between the flue-sheet and the arch, and the more distance the flame has to travel, the more heat goes through your sheet.

MR. JAMES SEDGLEY, Lake Shore & Michigan Southern Railroad—Mr. President, I would ask Mr. Smith, upon what grounds he makes the assertion that there is ten per cent. saving in the brick arch. Is it from experiments actually made in the use of the same engine with the arch, and without?

MR. SMITH—Yes, sir.

MR. SEDGLEY—My experience leads me to a different conclusion. Some ten years ago we were using the brick arch universally. The question came up of the royalty, and to determine its value we saw there was no better way than to run the engine for a given length of time, and see what the result would be. We did so, and at the end of the test, the same engine, without the arch, gave us just as good results as with the arch, and unless those tests are very accurately made I think they are misleading. The result was that we abandoned the use of the arch, and out of five hundred and forty engines we have not one equipped with it. If I have been misled in that, I should like to know in what way. My practice is to admit air just above the fire, through hollow tubes. That, with careful firing, has produced the best results upon our line that we have ever had.

In regard to Mr. Dean's statement I think all men who have had experience with a perforated pipe, without a dome, in this section of the country, have come to the conclusion that it is not practicable to run them, where our water is so impure that you cannot get your pipe far enough from the water, so that the priming of the engine will not carry too much into your cylinder. Take it in New England, where the water is pure, the thing is practicable, but in my judgment it can not be done any better there than with a dome, for I have tried it and speak

from experience. I have always had better results with a dome, and I would ask where you get the dryest steam? Is it nearest the water, or furtherest from the water? If I am wrong in these opinions, I would be glad to be put right.

MR. SMITH—It was stated a few moments ago, by Mr. Setchel, I think, that in England it is almost impossible to reduce the fuel bills. I read an article in a leading mechanical paper, not over two weeks ago, which stated that on the London, Brighton and South Coast Railway it was their daily practice to run their trains sixty-five miles without putting any coal in the fire-box. They used the brick arch and the deflector. Such economy as that would be impossible without the brick arch.

MR. J. H. FLYNN, Western and Atlantic Railroad—I am like Brother Sedgley. I have tried the brick arch, and I could find no economy in the consumption of fuel. Where you have extraordinarily good coal, that burns to ash, the brick arch might then be, to a certain degree, economical; but where you have what you might call inferior, but still very good coal, practice has demonstrated the fact to be that the brick arch is not economical. It is otherwise more expensive. I have tested it by running the same engine with the brick arch, and without, and she ran with less fuel without the brick arch than she did with it. It is the common custom with a great many of us, when a thing becomes to a certain degree popular, through the efforts of scientific men, who conscientiously believe that what they assert is correct, for us to be led into that belief ourselves. Now, a practical mind will oftener rely upon its own opinions. For instance, Mr. Dean makes an assertion which I know is not correct, and I know it from experience. He makes an assertion that it will be more economical to do away with the dome, and use the perforated pipe. We all know that the perforated pipe was used twenty or twenty-five years ago—mainly by the Eastern builders, and, as Mr. Sedgley said, their water being pure, they may be able to use it. But when you get down into our limestone country, it will not do. We all know that the old shape of the wagon-top boiler was a circle, not wider than the leg of the boiler. Now it is made ten inches wider. To show that an engine of that kind will perform better, I will state we had two of those engines on our road, previous to the war. After the war I built tubular boilers, and built them of just nine inches more width, and about ten inches higher than the old wagon-top. The old engines were noted for their hardness in getting steam. In other words, it required the engineer to take great care, and to require his fireman to be very attentive to his engine, to make the trip successfully. To my great astonishment, the new engines became very perfect steamers, and it was a subject of remark among the engineers, and I am willing to admit that

I didn't expect their steaming qualities would be very greatly improved, and I attributed it to the fact that there was a greater reservoir of steam. The reply might be made to that: why not make them still larger? but I answer there is a limit beyond which it would not be effective, and I had reached that limit. These engines are equal to any engines for steaming that are on the road, and I attributed its perfection in making steam to the increase in the size of the wagon-top. If you take away the dome, you take away a certain amount of your steam reservoir, as you might call it, and right there I am satisfied, from experience, that Mr. Dean is wrong and so far as substituting a perforated steam-pipe is concerned, I know it to be wrong. We have had them on the engines on our road, and have had to take them out. In the New England States, as was said before, where the water is pure, they may do very well, but how you can make it appear that the steam is dryer a few inches from the level of your water surface in your boiler than where you take it from the top of the dome, is a mystery to me. As to the brick arch saving fuel I have found that the only way to save in fuel is this: Get the engineers and firemen to run with as shallow a fire as your engine will make steam with. Some engines will make steam where the exhaust will not cut the fire. I have some engines that will run with a four to five inch fire, and others that will require six to seven inches. When you get them down to running with as shallow a fire as the engine will make steam with, then you will have arrived at the most economical way of running your engine.

MR. SMITH—With the first brick arch I put in I had the same trouble that Mr. Flynn had. I found there was no economy in it. I took the ordinary engine, with an old-fashioned diamond stack, and placed a brick arch in it, and found that the consumption of fuel was increased. I found that in front of the arch, next the flues, there was a large bank of sparks. I at once came to the conclusion that that body of sparks must be got rid of. By adjusting the petticoat pipe properly, creating a strong draft through the lower row of flues, I got rid of the sparks, and the result was economy of fuel. I would say though, that the brick arch works best always with a straight stack.

MR. LYNE—From Mr. Dean's paper in reference to the Joy valve gear, one might suppose he took the ground that the settling of the engine at the back end would not derange the movement of the valve. If that is what he means, it is certainly an error, for not many weeks ago I rode on an engine fitted with that gear—an engine running across the State of New Jersey. The gear has been somewhat improved since its original introduction into this country, but the settling of the engine

at the back end is still a serious objection to that gear, because it does derange the movement of the valve. Those of you who have seen the drawing of that valve gear know that the angularity of the slide which guides the ends of the valve rods, controls the movement of the valve, and if the engine settles down at the back, as they all do more or less, this slide will travel above the centre further than it does below the centre, consequently the valve will travel farther ahead, throwing it out of square. There are no means at present for correcting that error, and my conviction is that it will be a serious difficulty to overcome. Another difficulty with that gear is that the lead does not increase. Now, with the link motion, the lead does increase, and it is a thing to be desired. On this engine, if I remember rightly, the lead has been increased to three-eighths of an inch. They began on one-quarter of an inch lead, but at high speed it was found the engine pounded considerably, and so the lead was increased, until at present it is three-eighths. Now, in starting out of the station, with the lever at full gear forward, three-eighths of an inch lead is rather too great. Of course, after the engine gets in motion, running fast, that may not be too great, but it is a serious objection in starting. This gear is in its infancy, and of course it may be improved; but it seems to me it will be a long time before we find anything that will supersede the link.

In reference to the perforated pipe, I know that to be an excellent thing on stationary boilers, but, it is not a good thing on locomotives. In the latter your boiler capacity is reduced, and in climbing grades you are liable to work the water through the cylinders, and I think to adopt that would be a retrograde instead of an improvement.

Mr. Dean alludes to one thing which has not been mentioned in the discussion, which is the twisting of rocker-arms, and he advocates the making of steel castings, or something that is stronger. It seems to me that that is not going to the root of the difficulty. I think the rocker-arms are strong enough. I think if he wouid look at the valve and its proportions, he might possibly be led into a further discussion of the subject. The fact is, as I stated at our last convention, that with the increase of the boiler pressures, and the size of the loads, the engines have to carry, no steps have been taken to relieve the valve, and as I said then I say now, that we will have to do. There is no reason why the valve should be required to take more load than is required to bring it down on the seat. At my suggestion, there was, since our last convention, a combination of the Allen valve and the Richardson Balancing Device put on an engine on the New Jersey Central Railroad. Since that time the valves have been examined. They ran fourteen months, during which time the engine ran 44,169 miles, without repairs

to the valve. At the end of that time the engine went into the shop for repairs, and the valves were refaced, although they did not leak. Previous to that time the Allen Valve, unbalanced, had to be faced every six weeks, and the condition of these valve seats was such that they wouldn't stand facing more than two or three times more. Since that experiment was made on that engine, the same combination has been put on other roads, where, I have been told, they are working successfully. I am not interested in anybody's patent at all, and I do not blame master mechanics for not trying balanced valves, because we all know that as a rule they have been failures; but because some have been failures, I do not think it is beyond mechanical skill to produce a valve that will work successfully, and this combination, which was put on that engine has worked to the entire satisfaction of those who use it.

There is another point that ought to be considered. With the balanced valve, the internal lubrication of cylinders and valves ought to be looked to. I believe that valves and clyinders ought to have a constant lubrication—a thin film of oil on them at all times. For instance, an engine that has been pulling heavily, in coming into a station, the throttle being closed, the heat on the surface of the cylinder and valves will evaporate whatever moisture remains. In starting the engine it is often noticed that the piston and valves are dry and will groan, and if the engine stops in such a position that the valve covers all the ports, when the valve begins to move, it jumps. I have noticed them jump a quarter or five-sixteenths of an inch. If the surfaces were properly lubricated, that would not occur. Then, in running down hill, the lubricator is put in in unreasonably large quantities, and so I say that if we consider the unloading of the valve, and the proper lubrication of the cylinders, we will not have to increase the size of the rocker arms, and they will not twist off.

Another thing. It is well known, in the experience of every ordinary man, that a small eccentric wears better than a large one—that is, it will not get out of a true circle as quickly as a large one, especially upon the fast passenger engines. Mr. Porter, who has the reputation of building a good high speed engine, forges his eccentric on the shaft. He throws the shaft out of the centre, and turns off his eccentric, and the outside diameter is brought down to the surface of the shaft, and consequently he gets a very small eccentric. Some months ago, I designed an eccentric with a view of overcoming the difficulties of a large eccentric, and also of fastening them to the shaft.

Eccentrics for locomotives are round only when taken from a lathe; then by the aid of two or three set screws and a key, they are distorted

into the shape of a cam. Or, in other words, the eccentric touch the strap only upon two opposite sides. As a remedy for this evil, it is suggested that the eccentric, instead of having keys and set screws, be bolted fast to a flange secured to the axle by means of a key and set screws. This method of holding eccentrics is shown in the accompanying engraving, Fig. 1, which is drawn to a scale of 1½ inch to the foot. *J*, *K* represents a cast-iron collar, having a good, thick hub *B*, bored to fit neatly upon the axle *A*, *E*. *C* shows the eccentric bolted fast to the flange of this collar by means of the bolts *D*, *D*, *D*, having counter-bored heads.

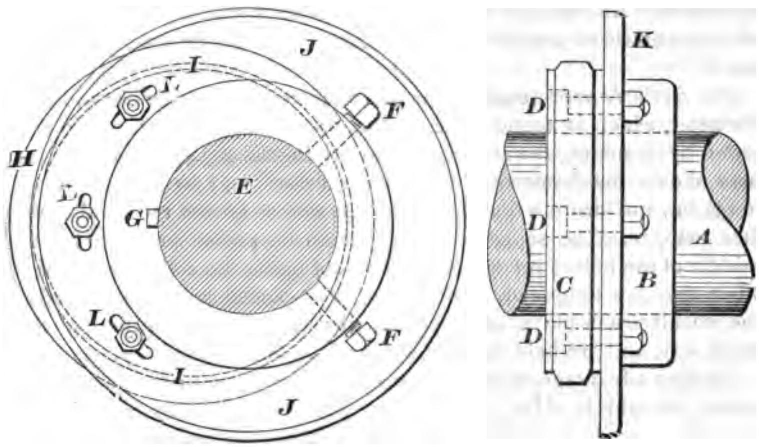

FIG. 1.

These heads have steady pins to prevent them from turning, in tightening the nuts. Before the wheels are placed under the engine, the four flanges, with their eccentrics, are made fast upon the axles by keys and set screws, as shown in Fig. 1, where *G* represents the key, and *F*, *F*, the two set-screws. The object of placing the set-screws in this position is to be out of the way of the bolts for holding the eccentric.

The collars shown in Fig. 1, can be easily placed upon the axle before the wheels are put under the engine, the amount of lap and lead of the valve being known. A line is drawn through the center of axle *E*, and bolt-hole nearest *G*, this line to be used to indicate the throw of eccentric. When this cannot be done, the collars may be easily shifted and secured in any position, after the wheels are in place.

By means of the slotted holes for the bolts through the plate, the eccentric can be easily and quickly shifted, little or much. All persons who have had any experience in setting valves, know the difficulty of attempting to shift eccentrics, to give a trifle more or less lead. When

the eccentrics are set and the set-screws again tightened, the tendency is to draw the eccentric back to its original position. Sometimes it occurs in consequence of the location of holes formerly made in the shaft by the points of set-screws, that when these screws are tightened with the eccentric in its new position, they exert a force which tends to slip the eccentric.

It will be observed that all the power here applied to the eccentric to hold it, is in such a direction that it does not spring it in the least. Yet there is less liability of its slipping with this device, than when held with set-screws. An essential feature of this device is, that it permits the use of an eccentric of smaller diameter than could possibly be used without it.

The circle *H* represents the outside diameter of an eccentric 15 in. in diameter, which is found necessary to prevent its being to much distorted by tightening the set-screws and driving the key. With the device here shown, the diameter of the same eccentric may be safely reduced to 13½ in., and insure a round eccentric, as well as greatly reduce the surface velocity. The set-screws, *F*, *F*, should be placed precisely in the middle of the hub to prevent them from springing the collar unequally when they are tightened. Eccentrics, to be placed upon the axle after the wheels are in place, are to be split through the belly instead of the usual way, and are held together by one bolt, or by a stud and key.

Another advantage of this device, is, that the eccentric may be placed nearer the middle of the axle, which removes them farther from the inequalities introduced by the rise and fall of the axle in the boxes. The rocker boxes, too, can be made longer there, giving a longer bearing upon the rock-arms, which is also advantageous. When it is desired to move any one of the eccentrics, it can be done at once, without disturbing the others, as is necessary, where the usual method of holding eccentrics by set-screws and keys direct, is employed.

It is understood that it is principally in rebuilding locomotives, these alterations will be foun of great practical value, as it would hardly pay to make such changes on one engine alone, while undergoing running repairs simply.

MR. SETCHEL—The time is up for adjournment; but I want to say a word in reply to Mr. Smith. There is a very great difference between running an engine in the yard as Mr. Smith's engines do, and running on the road. You can run in a yard with the door open all the time, or without any door, for that matter. But when you come to put the engine up to its full capacity, on a run of forty or fifty miles per hour, that makes a very different thing of whether you have the door open or not.

Mr. Smith—Our service is just as severe as the service of any other railroad. We are running all the time—every hour of the day, and every day in the week; I might say every minute of the day. To give you an idea of how important time is with us, we allow our engineers to clean their fires but once in twelve hours, and what will suit us will suit any road.

Mr. Taylor—I would like to say just a word in regard to running an engine with the furnace door open. The fuel we have to use in the East is very different from the fuel you have to use in the Western country The fuel we have to burn will burn quick, and will make a very black smoke when you first throw it into the fire, and after it has a chance to ignite a very little, the smoke is entirely gone, and I think Mr. Dean drew his inference from his own observation, that by leaving the door open for two or three revolutions of the engine, you would get rid of the black smoke. In Massachusetts, it is almost a law that you cannot make black smoke, and you have got to devise every means you can, for preventing it. We accomplish that by leaving the furnace door open for two or three revolutions of the engine, whereas, if we had an engine that was admitting air enough at all times, the trouble would be to keep up our steam. It would be admitting too much air. But when you first throw the coal in, you want to admit a little more air, until you have run two or three revolutions. And that is our experience, in our practice, we are obliged to instruct our men not to have black smoke if they can avoid it. We, as a general thing, get pretty good intelligent men for firemen, and can fairly say that our cost of fuel per mile run will compare favorably with Western Roads.

Mr. Sedgley—I move that the discussion upon this paper be closed.

Agreed to.

The President—The Finance Committee consists of Mr. George Richards, Mr. M. M. Pendleton, and Mr. T. B. Twombly, and they will be ready at all times to receive your dues.

The Convention then adjourned until Wednesday, at 9 o'clock.

SECOND DAY'S PROCEEDINGS.

The Convention was called to order by President Wells at 9:15 A. M.

THE SECRETARY—I have an application here for Associate Membership of Angus Sinclair, mechanical engineer of the *American Machinist*, recommended by R. W. Bushnell and George Hackney.

The Secretary then read the clause in the Constitution regulating the admission of Associate Members, and stated that there were now 17 Associate Members and three vacancies. He moved that the application be received and a Committee appointed. Agreed to.

Mr. L. F. Lyne, Mr. L. C. Noble, aud Mr. A. Donaldson, were appointed as a Committee.

THE PRESIDENT—I would remind the Convention that according to our rules, the report of the Committe on subjects for discussion at our next Annual Convention should be put in at 1 o'clock, and I would suggest to any of the members present who have subjects which they wish discussed or brought to the notice of the Convention, to hand them to this Committee before 1 o'clock. That Committee consists of James Boone, John H. Flynn and George Richards.

MR. SETCHEL—Mr. President, before commencing these reports, there is a little matter I would like to bring up. t has been customary in the Association to retire our oldest and best members and place them on the roll of honor which entitles them to every privilege of the Association, with the exception of that of voting. We have now two honorary members on the list: Isaac Dripps, an old master mechanic of the Pennsylvania Railroad, one of the oldest master mechanics in the country, and a former Vice-President of this Association, W. A. Robinson, of Hamilton, Canada. We have among us to-day a man who is one of the oldest members, and who is probably the oldest in the Association, being over 70 years old, a man who has always been faithful as a member, and a man who has served us on several very important committees and presented us with some valuable reports. He has retired from railroad business and probably will never enter it again, and I would move that that gentleman, whose name is J. L. White, formerly of the Evansville & Crawfordsville Railroad, be elected by acclamation an honorary member of this Association. Agreed to.

THE PRESIDENT—The next matter that will come before the Association is the report of the Committee on the most practicable and best system of paying premiums to engineers and firemen to induce economy in working locomotives.

The Secretary read the report of this Committee, which, on motion, was received

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To the American Railway Master Mechanics' Association:

Your Committee appointed to investigate and report upon the following subject: "The most practicable and best system of paying premiums to Locomotive Engineers and Firemen to induce economy in working locomotives," beg leave to submit the following report:

Your Committee have assumed that it *is* practicable to induce economy in the use of fuel in locomotives by allowing premiums to the men in charge.

We have found that in many cases premiums have been given for the engine running the cheapest for fuel, but as this is often unfair on account of the varying circumstances, and that light slow trains, with specified hours per day, make it easy for one engine upon a certain run to always make the best showing, as against others where the trains are heavy and fast, or received upon a Division behind time, and in bad hours and uncertain days, together with many other hindrances which render it impossible for the men in the latter case to compete with the others, although the individual effort of the men may be greater and deserving of greater credit than that of those who receive the premiums.

A system of premiums should, therefore, be used which will give each individual the full benefit of his own efforts.

This can only be done by fixing a line which is the average of good and bad management or work, and pay the men according to their standing.

If a man goes much to the wrong side of the line he soon has it pointed out to him, and if he does not mend and show a better record he will soon find that his services are not needed.

The keeping of records of the fuel used, and publishing their record monthly to the men, without offering any premiums is a great inducement to the men to try and save fuel and run cheaply.

The success of any system of business will depend almost entirely upon the accuracy of the records kept.

We therefore recommend a system which has been tried on one of our prominent trunk lines, and found to work very successfully.

This system is based upon the individual work of each crew or engine compared with an average made for the same work done for a previous period of time.

Proper measures must be taken to get an accurate record against each engine, of the amount of coal consumed, miles run by engine, and average train.

As the fuel consumed should be represented in work done we consider that the work unit of comparison should be number of pounds of coal per car drawn one mile or car mile, this being more convenient than by ten miles.

Assuming that proper arrangements are made for measuring or weighing the coal accurately, the amount of coal charged up against an engine for a month is kept, and it is found that the engine has burned, say 100 tons or 200,000 pounds of coal during the month, and for the work done has run 2,500 miles and drawn an average train of 20 cars, making 50,000 miles for one car, or car mile.

We then have 200,000 divided by 50,000 car miles, or 4 pounds of coal per car mile. We now say to the engineer and fireman, we have found that for the past month, or any other given time, it has taken 4 pounds of coal for every car mile, now, we will pay you as a premium, one half of all you save from that amount.

Our records for the next month show that the engine has run 3000 miles, and has drawn an average train of 25 cars, or 75,000 car miles, but, instead of using 200,000 pounds of coal, they have used 260,000 pounds, or 3.46 pounds per car mile.

We then have a saving of 0.54 pound per car mile, which, for 75,000 car miles, makes 40,500 pounds saved, which, at $2.50 per ton, would be $50.62 saved; one half of this, ($25.31) to be divided between the engineer and fireman—a fair amount, surely, for the exercise of a little care and skill, during the regular performance of their duties.

After a time it may be found that the old way was so wasteful, that the amounts made as premiums are too great, and a new basis can be made on which to make the comparison.

This is the method of dealing with the men when each runs his own engine, either on some stated train or in the "rounds," each premium offered is for beating the previous work of each man him-

self, and will in no way compare or conflict with men who are running engines in different service, and under different circumstances.

But many of the roads are working into, and adopting the plan of running the engines in the "rounds," turning them at the end of each trip, as soon as the fires are cleaned and any necessary light repairs are done and starting them with a new crew of men. By this method we would lose the individual effort on each engine, and a careless man would lose what a careful one made. To remedy this, the record must be kept with each man or crew, engineer and fireman, and will be found to be fully as fair as when kept against the engine, when run by one man. For example, Engineer Smith with Fireman Jones, take out engine No. 12 to-day, with 4,000 pounds of coal on the tender. They are charged with this amount; upon the trip they get 8,000 pounds more, making 12,000 pounds. When they deliver up the engine, they have left 3,500 pounds, showing that they have used 8,500 pounds for the work performed, which is, we will say for example, 100 miles with an average train of 30 cars, or 3,000 car miles.

The record for the month is kept against Smith and Jones.

The coal used charged, and the car miles credited, and at the end of the month, if the pounds per car miles comes below what is the established average, the proper amount is paid.

We have given a general outline of the system used upon one of our largest trunk lines, and with great success. We will now try and lay down a system for giving premiums for economical use of fuel, giving the necessary accounts, methods of measuring fuel, manner of keeping records of the car mileage, etc., also, copies of the necessary blanks, etc.

The first requisite in a system such as we have now under consideration, is a proper fuel account, also, the necessary trestles, coal-pockets, scales, etc., for handling and weighing the coal accurately.

Assuming that all roads which are completed have the necessary arrangements for keeping account of all coal sent to a coal station, and the ordinary cranes, chutes, etc., for putting the coal into tenders in the most economical manner.

Each coaling station should be debited with the full amount of coal sent to it, and credited with that delivered for use.

An engine arrives at the coaling station and the engineer fills out blank No. 1, of which he keeps a copy on the stub, for the amount of coal delivered to the engine, and hands this to the man in charge of the pocket, and these are entered in a book provided for that purpose. The blanks are sent daily to the office of the fuel clerk, who keeps the daily record of the fuel with the men or engines, as the case may be. An inventory at the coaling station at the end of the month proves that the measurements and charges are correct, and the engineer having his stubs is able to know that he is not charged with coal he has not received.

In order to illustrate more clearly the manner of keeping these accounts, we will explain the proposed system by making an application to a supposed railway. The railway runs from B. to H., about 90 miles. The principal coaling stations are at B, and H. while at A. and C. there are arrangements for coaling when necessary. The average passenger train 6 cars, for freight, 30 cars. The traffic usually runs loaded from B. and part empty from H. to B. Cars often are drawn empty over a railway, and consequently if the record was kept of the number of cars without regard to loaded or empty, injustice might be done to those who, from one cause or another, should get more empty than loaded, while the reverse might be the case with others.

An adjustment between loaded and empty cars and other kinds should be made, and as a basis a loaded box car should be taken as a unit. It has been found that on all kinds of roads, three empty cars are about equal in resistance to two loaded cars of the same kind, and the following adjustment should be made for the different kinds of cars:

All loaded 8-wheeled cars, Box, Stock, Gondola, Flat, &c., to be counted as a loaded car; three empties of the same kind to be counted two loaded cars; two 4-wheeled cars, loaded to be called one car; four empty 4-wheeled as one car; two passenger, baggage and express cars as three loaded cars.

As trains average, this adjustment has been found to be very nearly right. The reduction of passenger equipment to the freight basis is necessary, for often mixed trains are run.

After getting coal at B. in the manner set forth, the engineer starts with train for H., his train consisting of, say 30 loaded box

cars. The conductor enters these on a blank (No. 2.) On arriving at A., 30 miles from B., 20 more cars are added to the train, and the train goes through to H. The conductor's blank shows 30 cars drawn 90 miles, and 20 drawn 60 miles, making a total of 3,900 car miles for the trip. The engine had 12,000 pounds of coal when starting and 1,000 pounds when arriving at H. At H. the engine received 12,000 pounds of coal and the 1,000 make 13,000 pounds.. Now, on the trip back the cars are mixed. There are 20 loaded and 25 empty leaving H., and at C., 30 miles from H., 10 more loaded and 5 more empty are added.

The conductor enters on blank (No. 2) 20 loaded 90 miles, 10 loaded 60 miles, and 25 empty 90 miles, and 5 empty 60 miles, which makes 2400 loaded and 2,550 empty car miles; the 2,550 being equal to 1700 loaded car miles, we have 4100 loaded car miles for the trip.

The engine burns, say 10,000 pounds of coal on the trip to B., and has made 8,000 car miles for the round trip.

Here we have a basis on which to award premiums for the round trip from B. to H. and return.

The engine has consumed 21,000 pounds of fuel and has accomplished in work 8,000 car miles, or an average of 2.62 pounds of coal per car mile.

The conductor's reports (blank No. 2) is sent to the fuel clerk, and he has the data for the complete record of the mileage of the engine work done and fuel used.

The plan proposed gives approximately correct results as to the work done, and if at times trains run irregularly, it is found that in three months all have come around all right, and all have had equal show at the easy and hard circumstances.

Records kept in the manner proposed, show that the greater average train gives the best results in earnings per car mile, even with a greater consumption of coal per engine mile, making it desirable for the engineer to take all the cars possible and to run as little light as possible. When engines are run the rounds with the men, the record being kept with the men and the coal charged where the engine is taken and credit being given where the charge is relinquished.

For greater convenience and accuracy it is found better to measure the coal by cubic measure, rather than by weight, as coal shrinks more in weight by exposure than in bulk; also, it will take up a large weight of moisture if the coal piles are not properly covered.

For convenience of measuring the coal upon the tender at the time a crew takes the engine in charge, the tenders should be marked showing how full they are, with half a ton, one ton, one and a half tons, &c. up to a full tender.

The fireman would be required to bring his engine to the coaling station, or engine house, with the coal properly leveled off, so that the amount then on the tender can be properly noted by the pocket foreman, or other person authorized to receipt for the coal (Blank No. 3), when the engine is returned to the round house; also, by marking off the tanks to show the amount of coal upon it, the engineer and fireman have a sure method of ascertaining whether the amount charged is correct.

When the coal is only piled upon a platform and is shoveled upon the tender from the platform or a car, the amount given to each engine can be ascertained by the weight marks upon the tender.

In this case the station agent, when the coal is taken, takes the checks or orders (Blank 1), and returns it to the fuel clerk as a receipt for the coal for which he is responsible.

When engines are set off for each passenger train, the comparison should be made with each train, but, if passenger engines run the rounds with the men, a unit can be arrived at by the general average of all passenger trains.

When men run the rounds it often may happen that the same engineer and fireman might not go out together two trips in succession and it will be found necessary to keep the accounts with each man, both engineer and fireman.

Engineers will be required to fill out blank No. 4 at the end of each month, which shows the amount of coal used and engine mileage made by them. This is done for a check upon coaling station.

By the system set forth each man will get credit for the work done by himself; it would teach economy, and the man would soon find it was for his own interest to keep the engine up in the best

No. 2.

X. Y. & Z. R. R.

. . . . Division.

Date 188

Train No . . . .

Engine No . . . .

Engineer . . . .

Fireman . . . .

Conductor . . . .

No. of Cars.	Kind of Cars.	Where Taken.	Where Left.	Loaded or Empty.	Mileage.

No. 3.

Engine No . .
Engineer. . . . .
Fireman. . . . .
Coal on tender, leaving . . . lbs.
" " arriving. . . . "
Wood on tender, leaving . . . cds.
" " arriving . . . "
. . . .
. . . . . 188 . Foreman.

Engine No . .
Engineer. . . . .
Fireman . . . .
Coal on tender, leaving . . . lbs.
" " arriving . . . "
Wood on tender, leaving . . . cds.
" " arriving. . . "
. . . .
. . . . . 188 . Foreman.

No. 1.

Engine No......	Engine No......	Engine No......	Engine No......
Train Nc......from.........to.........			
Engineer.........	......................Sta.	....Sta.	....Sta.
Fireman..........			
Coal on tender......R. H.........lbs.	......................188...	. ...188...	....188...
Received at......... ....“			
“ “ ....“	Coal ....lbs.	Coal....................lbs.	Coal....................lbs.
Total................ ....“			
Wood rec'd ....Sta............cds.	Wood........ ....Cds.	Wood................Cds.	Wood ....Cds.
Coal on tender arriv'g...R.H...lbs.			
../....................			
...........188... Eng.	.... Eng.	.......................Eng.	.... Eng.

No. 2.

X. Y. & Z. R. R.

. . . . **Division.**

Date 188

Train No . . . .

Engine No . . . .

Engineer . . . .

Fireman . . . .

Conductor . . . .

No. of Cars.	Kind of Cars.	Where Taken.	Where Left.	Loaded or Empty.	Mileage.

No. 3.

Engine No . .	Engine No . .
Engineer.	Engineer. . . . .
Fireman.	Fireman . . . .
Coal on tender, leaving . . . lbs.	Coal on tender, leaving . . . lbs.
" " arriving. . . . "	" " arriving . . . "
Wood on tender, leaving . . . cds.	Wood on tender, leaving . . . cds.
" " arriving . . . "	" " arriving. . . "
. . . .	. . . .
. . . . . 188 . Foreman.	. . . . . 188 . Foreman.

No. 4.

X. Y. & Z. R. R.

Monthly Report of Engineers of Engines, Trains, and Fuel Used.

. . . . Engineer . . . . 188 .

DATE.	FIREMAN.	ENGINE NUMBER.	ENGINE MILEAGE.	COAL USED	REMARKS.

Engineers will fill out this blank and send to the office of Master Mechanic, promptly, on the last day of the month. In the column of mileage he will give the number of miles allowed between the stations to which he has run.

The coal used will be the difference between that taken with the engine, together with that received and the amount receipted for when giving up the engine.

No. 5.

X. Y. & Z. R. R.

. . . . Station 188

Daily Report to Superintendent of Motive Power.

Estimated amount of coal on hand at 6 o'clock P. M.:

In the pockets . . . . Tons.

In the cars . . . . "

In the stock pile . . . . "

What amount of the above coal is anthracite? . . . .

Are the pockets in good order? . . . .

If not, what is out of order? . . . .

. . . .

Please note below any causes of trouble or delays during the day.

....

....

....

....

....

What is the quality of the coal that was unloaded during the day?. . .

If bad, give name of mine . . . .

. . . .

Signature of Foreman.

No. 6.

X. Y. & Z. R. R.

Daily report of coal received for Company's use at. . . . .

. . . . 188

No. of Car.	Weight.	Where from.	Kind of Coal.	Remarks.

No. 7.

X. Y. & Z. R. R.

Daily report of coal delivered to engines, at . . . . Station

. . . . 188 .   . . .

Foreman.

Engine's Number.	Engineer.	Fireman.	Kind of Coal.	Amount in Pounds.	Remarks.

No. 8.

X. Y. & Z. R. R.

Report of Coal consumed at . . . . Station, during the month of 188

No. of Engine.	Kind of Coal.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Tot. No. Tons Soft Coal.	Tot. No T'ns Hard Coal.

I certify that the quantity of coal taken by engines, as specified in this report, is correct.

Examined and found correct.

. . . . *Station Keeper.*

. . . . *Sup't* . . . . *Division.*

No. 9.

X. Y. & Z. R. R.

. . . . DIVISION.

[C]oal consumed and premiums earned by Engineers and Firemen:

[EN]GINEER.	Total amount Coal Used. Lbs.	Loaded Cars Hauled.	No. Trips.	Total amount Coal Saved, Lbs.	Coal Used in Excess of Limit.	Prem. Earned.	
						$	Cts.

No. 10.

X. Y. & Z. R. R.

. . . . DIVISION.

Report of coal consumed and premiums earned during month of . . . . 188 .

Engineer.			Mileage.	No. Trips.	No. Eng.	Coal Consumed.	Car Mileage.	
Fireman.	Class.	Engine Runs.					Loaded.	Empty.

Engineer.	Engine Runs.	Class.	Mileage	No. Trips.	Coal Consum'd	Cars Hauled	Limit.	Coal Saved.	Premium.	
									$	Cts.

Fireman.	Engine Runs.	Class.	Mil'age	No. Trips.	Coal Consum'd	Cars Hauled	Limit.	Coal Saved.	Premium.	
									$	Cts.

No. 11.

X. Y. & Z. R. R.

. . . . DIVISION.

Record of coal consumed and Premiums earned for month of. . . .

. . . . 188 .

AMES.	Class.	Engine Runs.	Mileage.	Trip Number.				Engineer.		Fireman.	
				No. Engine.	Coal Consumed.	Cars Hauled.	Fireman.	Total Amount of Coal Used.	Total No. of Cars Hauled	Total Amount of Coal Used.	Total No. of Cars Hauled

No. 12.

X. Y. & Z. R. R. Co.

. . . . 188

Superintendent . . . . *Division.*

The following is a report of the trips made, coal consumed, and premiums earned by the . . . . on . . . . Division, for the month of . . . .

NAMES.	Total Amount of Coal Consumed. Pounds.	No. Trips.	Total Amount of Coal Saved. Pounds.	Total Amount of Coal Used in Excess of Limit. Pounds.	Prem. Awarded.	
					Dollars.	Cents.

No. 13.

X. Y. & Z. R. R.

. . . . DIVISION.

NOTICE TO ENGINEERS AND FIREMEN:

’remiums will be paid for the month of . . . . 188 . . Engineers and Firemen, based upon the following limits:

ENGINE RUNS.	Mileage per Round Trip.	Limit pounds, Coal per Car per Mile.

Mr. Wilder—I supposed that the report had been in the hands of the Secretary long enough for it to be printed, as he hurried me up in the preparation of it, and that was the understanding, that if I got it in by a certain time, he would have it printed. If it were printed probably the members would have been able to form a better idea of what the system proposed is. I am ready to answer any questions in regard to the subject that members may see fit to ask.

There being no discussion of this report, the President called for the report of the Committee of research on improvement in boiler construction.

Mr. Johann, Wabash & St. Louis Railroad—In presenting this report I wish to introduce Mr. George P. Brook, a young man in my office, to whom the work of accumulating the facts in regard to boilers is mainly due. As he has done the most of the work, I think it is only proper that he should read the report.

Mr. Brook read the report, which, on motion, was received.

REPORT OF THE COMMITTEE OF RESEARCH OF THE MASTER MECHANICS' ASSOCIATION ON IMPROVEMENTS IN LOCOMOTIVE BOILERS, JUNE, 1883.

Gentlemen—The announcement of the members to serve on the Committee of Research to investigate the subject of Improvements in Boiler Construction, was not made until October 10, 1882.

A meeting of the Committee was then called to meet at Indianapolis on November 21st, but through some misunderstanding the meeting miscarried and resulted in nothing being accomplished.

The succeeding month was an exceedingly busy and trying one, which, in conjunction with other circumstances, rendered it impossible to have a meeting during that month.

A meeting was then called for January 17th, at Cincinnati, at which the members of the Committee were present with one exception, and Messrs. Wells and Setchel by invitation.

At this meeting it was decided, owing to the short time left in which to do the work, not to enter into any series of experiments or to prepare an elaborate discussion on the subject.

It being deemed more advisable to secure as much data as possible in an informal way, for this year's report, and reserve the thorough digestion of the subject for the succeeding year if the Association so decided.

In pursuance of this policy the following circular letter was addressed to those members of the Association who were deemed to be the best situated to furnish the data required by your Committee:

SPRINGFIELD, ILL., February 3, 1883.

Having been appointed Chairman of the Committee of Research of the Master Mechanics' Association to investigate the subject of Improvements in Locomotive Boilers, I should like very much to have your co-operation towards making our report as valuable as possible.

At a meeting of the Committee held at Cincinnati it was decided not to issue any circular embodying direct questions, it being deemed more advisable to secure as much general information as possible for this year's report, and reserve the direct questions on subjects that may present themselves for next year's report.

In furtherance of this object we should like very much to have your views on the subject in question in such shape as you may choose to present them, together with drawings and descriptions of any boilers that you may have in operation or contemplation, that have or will possess any differences, however slight, from the types now in general use.

I should like your reply addressed to me at Springfield, Illinois, not later than April 1, 1883.

Very much to our disappointment only nine replies were received to over thirty circular letters that were sent out, but the answers and drawings that were received are valuable, and the Committee return their thanks to those who responded.

In order to secure data for making a comparison between the English and American practice, similar circular letters modified to suit the circumstances were sent to seven of the leading English Master Mechanics, and replies earnestly solicited.

As a result four replies and five tracings of boilers were received.

This result has almost led us to conclude that our English brethern take more interest in such matters than we do in America.

In presenting these replies and drawings to the Association, it is not the intention of the Committee to enter into any elaborate discussion as to the merits of the different boilers, but will simply take each one up separately and call attention to the peculiarities and points of difference from the ordinary type, that each may possess, hoping thereby to provoke a discussion and secure an expression of opinion as to the merit of the different points that may be brought out.

In this connection we wish to say that the order in which th are taken up is simply a matter of convenience and is not intended to give precedence to any one reply.

PLATE 1 is a boiler designed by Howard Fry, of the New York West Shore & Buffalo, for the Consolidation Engines to be used on that road.

Size of cylinders ——.

Diameter of drivers ——.

This boiler is of the straight top type, is 55 inches in diameter at smallest ring, and has 169 2¼-inch flues, 13 feet 6 inches long. The fire-box is 8 feet in length, with arched crown-sheet, stayed to boiler crown by long stays rivetted over at both ends. It has fire brick arch supported by water-tubes, which enter the flue and crown-sheets.

All longitudinal seams are butt-jointed with welt strips inside and out, the external welt strip butting up against the circumferential seam, and the internal one lapping over and taking two of the circumferential seam rivets.

The front flue sheet and back-head are thoroughly stayed by angle plate stays.

PLATE 2 is another boiler designed by Howard Fry, of the New York, West Shore & Buffalo Railway, for the Standard six-coupled side-tank switching engines used on that road.

Size of cylinders, 18 by 20 inches.

Diameter of drivers, 44 inches.

This boiler is also of the straight top type, is 50 inches in diameter at smallest ring, and has 169 2-inch flues, 9 feet 11 inches long. The fire-box is 62 inches in length, with sloping grate and fire-brick arch. This arch is supported by water-tubes which enter the flue and fire-door sheets.

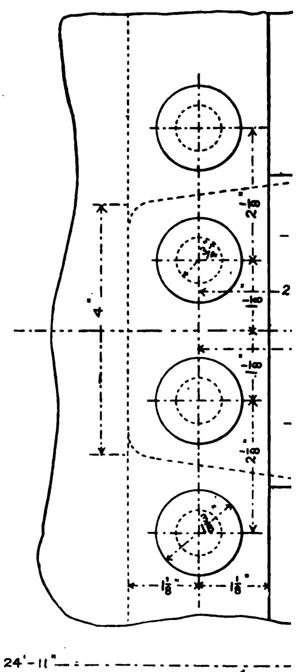
This arch extends entirely back to the fire-door sheet with a 12 by 24 inch opening in each back corner of the arch.

The general construction of the boiler is similar to that for the Consolidation engine, and the same remarks are applicable.

PLATE 3 is the boiler of a Consolidation engine, built by Theo. N. Ely, of the Pennsylvania Railway.

Size of cylinders, 20 by 24 inches.

Diameter of drivers, 50 inches.



4"
2 1/8"
1 1/8"
1 1/8"
2 1/8"
1 1/8"
1 1/8"
24'-11"

This type of boiler you are all very probably familiar with, it having a sloping boiler-crown.

It is 54 inches in diameter at smallest ring, and is made up of sectional rings 38 inches in length. It has 138 2½-inch flues, 12 feet 11 inches in length.

The fire-box is 8 feet long, with water-grates and fire-brick arch, supported by water-tubes entering the crown and flue sheets.

PLATE 4 is the boiler of an eight-wheel engine, also built by T. N. Ely, of the Pennsylvania Company.

Size of cylinders ——.

Diameter of drivers ——.

This boiler is wagon-top in form, is 54 inches in diameter at smallest ring, and has 193 2¼-inch flues, 11 feet 1 inch long. The fire box is 72 inches long, with flat crown stayed by crown-bars, and has fire-brick arch supported by water-tubes entering crown and flue sheets. The front barrel, flue and smoke-arch sheets are secured together by a peculiar wrought-iron ring, each sheet being rivetted to this ring independent of the others.

PLATE 5 is a boiler, designed for an eight-wheel engine, by Jas. Sedgley, of the Lake Shore and Michigan Southern Railway.

Size of cylinders ——

Diameter of drivers——

It is of the wagon-top form, is 50 inches in diameter at smallest ring and has 199 2–inch flues, 11 feet 6 inches long.

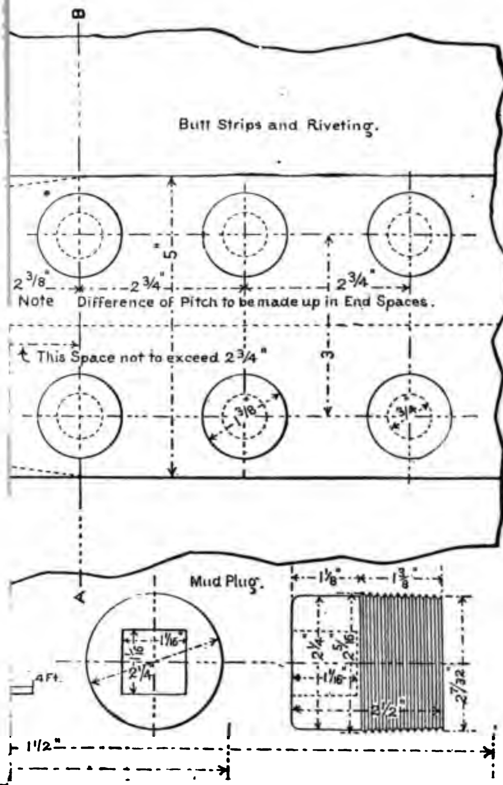
Mr. Sedgley says, "while there is very little about it that is new or novel, it seems to embody what a long experience has shown to be required, to give us the most satisfactory service. All seams are welted. My belief that this is the best method for re-enforcing them has been abundantly confirmed. We have never ruptured a welted seam nor do we find any furrowing at such seams.

The crown bars are of the skeleton form, with a plate of thin iron resting on the washers, to prevent sediment from settling on the crown sheet through the opening in the crown bars. The third and fourth rows of stay-bolts are hollow to admit air to the fire.

PLATE 6 is a boiler designed by Jas. Sedgley, of the Lake Shore and Michigan Southern Railway, for use on a Mogul engine.

Size of cylinders, 19x24 inches.

Diameter of drivers ——.



B
Butt Strips and Riveting.
5"
2 3/8"
2 3/4"
2 3/4"
Note Difference of Pitch to be made up in End Spaces.
This Space not to exceed 2 3/4"
3
3/8
3/4
A
Mud Plug.
1 1/8"
1 3/8"
1 1/16"
2 1/4"
4 Ft.
5/16"
2 1/2"
2 7/32"
1 1/2"

This boiler is of the straight top type, 51 inches in diameter at the smallest ring and tapering back to 54 inches at back end of barrel. It has 150 flues, 2½ inches in diameter, and 12 feet 4 inches long.

Fire box is 72 inches long and has corrugated side sheets.

PLATE 7 is a boiler designed by Thos. B. Twombly, of the Chicago, Rock Island and Pacific Railway, for a 17x24-inch cylinder, eight-wheel engine.

This boiler is straight top in form, is 49 inches in diameter at smallest ring, and has 155 2-inch flues, 11 feet 5 inches long. The fire box is 66 inches long, and has an arched and sloping crown sheet stayed to the boiler crown by long, direct stays, screwed into the sheets and rivetted over at both ends.

PLATE 8 is a boiler designed by Wm. Woodcock, of the Central Railway of New Jersey, for an eight-wheel passenger engine.

Size of cylinder, 17x24 inche .

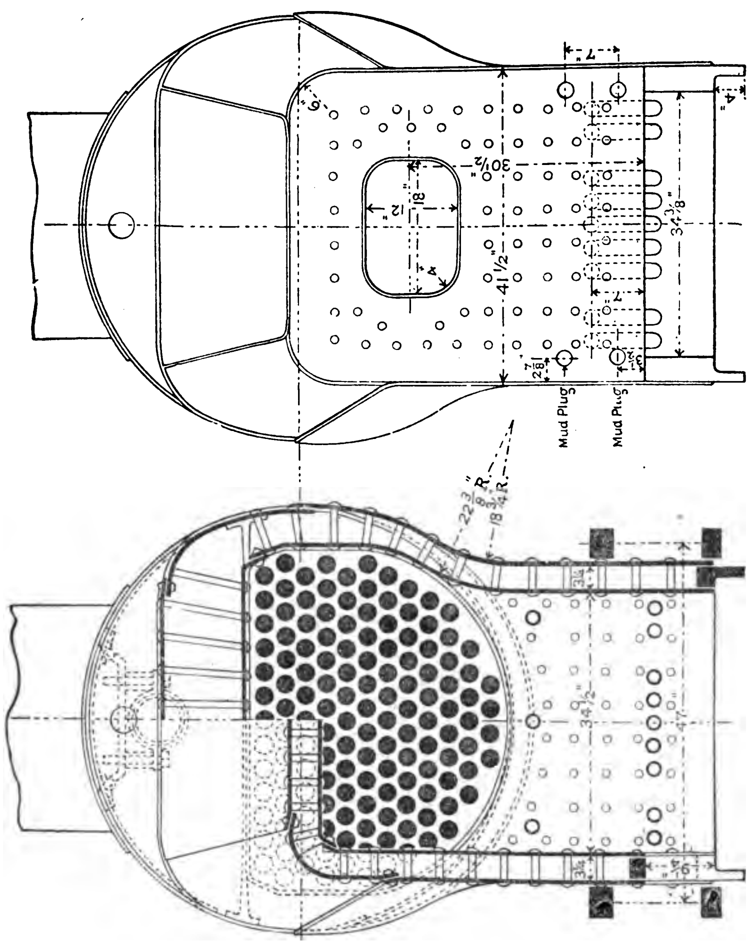
Diameter of drivers, 68 inches.

This boiler is 51 inches in diameter at smallest ring and has 183 2-inch flues, 11 feet 6 inches long. Fire box is 9 feet 6 inches long by 43¾ inches wide, with water grates.

In regard to this boiler, Mr. Woodcock says: "In compliance with your request in reference to contributing some data for your report on improvement of the locomotive boiler, I have furnished to you a tracing of our standard boiler for burning anthracite coal, for a locomotive with 17x24-inch cylinders, driving wheels 68 inches, and used in passenger service.

"I have just completed a new boiler as per tracing. It is made of Otis steel plate throughout. We have a number of this class of boilers in every day service, on fast passenger trains, which are performing very satisfactorily. I believe this to be a good type of boiler for burning anthracite coal, and while it may not be of interest to you Western people, yet I thought it might be of interest to you to know what we are using in this section of the country, to get the best results.

"One of the peculiarities of this boiler is in the construction of the fire box, to get increased grate area, which is so essential and necessary in using the above fuel.



Transverse Section and End View of Boiler for Consolidation Engines of Pennsylvania Railroad. **See Plate III.**

"You will notice that the width of the boiler at the fire box is made the full width of the outside of the frames and rests on the top of the same, which gives us a width inside of fire box of nearly 44 inches, while the usual width of a standard gauge boiler is about 34 inches wide inside.

"We have some boilers in service for locomotives having cylinders 18x24 and 19x24 inches, 68-inch driving wheels, that have fire boxes 44¾x126 inches, with 200 tubes 2 inches in diameter and 11 feet 6 inches long, also made to rest on top of frames.

"This class of engines are making some very fast time and are establishing a good record.

"These boilers may seem very large to you, but in the use of this fuel, and to furnish steam to supply the cylinders at the high rate of speed required to be run, it becomes a necessity to provide for a large heating surface."

PLATE 9 is the boiler of the Philadelphia and Reading Railway containing the Wootten fire box, and presented by L. B. Paxon engineer of machinery of that road.

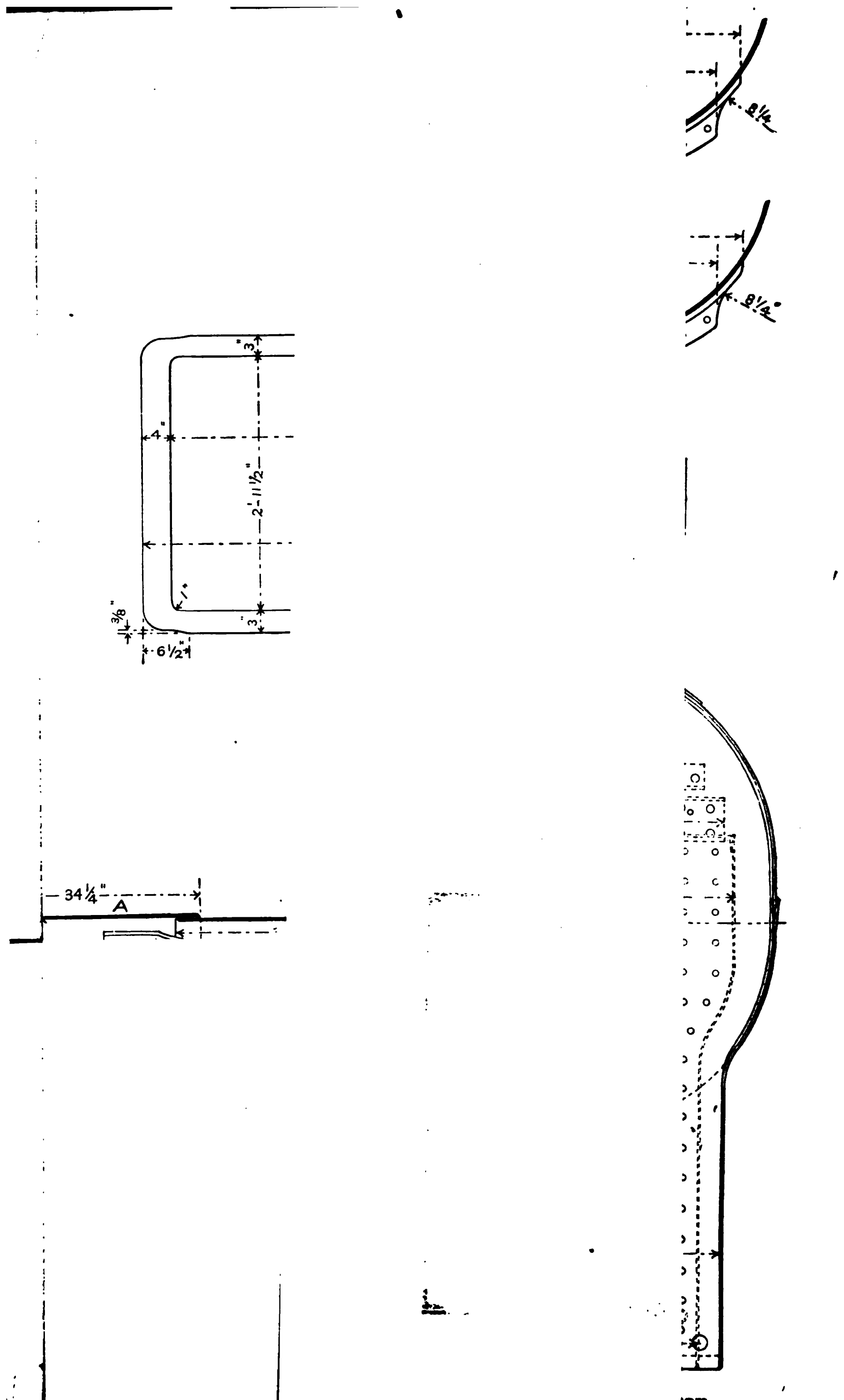
This style of boiler you are all familiar with, and we will only give some of the dimensions of the boiler represented by the drawing.

This boiler is intended for engines in passenger service. It is 51⅞ inches in diameter at smallest ring, and increasing in diameter to 57½ inches at dome. It has 184 2-inch flues, 9 feet and 2 inches long. The fire-box is 8 feet 6 inches by 8 feet wide, with a combustion chamber 35 inches in length.

PLATE 10 is a novel design for a locomotive boiler, submitted by Chas. A. Smith, Associate member, and for his theory of the design we cannot do better than quote his letter:

"In presenting to the Committee on Boiler Construction a novel design for a locomotive boiler it is desirable to say a few words explaining the reason for making such design.

"The increase in the demands of the operating department upon the motive power, has led to the use of heavier engines, more weight for adhesion, more cylinder power, and more boiler, but the growth of the latter has met with restrictions. Among them, as follows: The increase in the diameter of the shell requires the


3"
4"
2'-11½"
3"
3/8"
6½"
34¼"
A
8¼
8¼"

centre to be raised until we find an engine which appears top-heavy, although only so in appearance.

"The use of the so-called oval boiler at sea has been exceedingly successful, until we find that triumph of marine engineering, the Servia, with steel boilers 16 feet across, 18 feet high and 19 feet long, working with steam of 90 pounds pressure. Not as high as carried by locomotives, but considering the size of the shell many times greater in proportion.

"The accompanying tracing is only intended to show the application of the oval boiler to locomotives, and the flat sheets of the fire box are to be stayed in any approved manner, and a dome can be added where desired.

"The boiler shown is 6 feet by 4 feet in cross section, and the 24 inches of flat sheet on the sides are stayed across by 1-inch bolts every 6 inches with 1¼ inch overthreaded enlarged ends, with nuts inside and outside the shell and with outside washers. The tubes are spaced so as not to interfere with these bolts, thus providing room for circulation.

"The top of the shell is 10 feet from the rail, the centre 7 feet and the bottom 4 feet.

"The shell is thus set low, which can be done by the use of outside valve gear—Joy's, for instance. The full 6 feet is, of course, not essential. The driving wheels are 6 feet in diameter.

"For comparison I state the general dimensions and heating surface of a few of the large passenger engines of the present day.

	P & R Railway.	Central of N. J. 169.	W., St. L. & P. 105.	Oval Boiler.		
				6 ftx4 ft.	5½ftx4ft.	5 ft. x4 ft.
Height from Rail to top of Shell	10 ft 1 in.	9 ft. 10 in.	8 ft. 10 in.	10 ft. 0 in.	9 ft. 6 in.	9 ft. 0 in.
Height from Rail to centre of Boiler	7 ft. 8 in.	6 ft. 10½ in	6 ft. 8 in.	7 ft. 0 in.	6 ft. 6 in.	6 ft. 6 in.
Heating Surface	1137 sq. ft.	1320 sq. ft.	1255 sq. ft.	1600 sq. ft.	1400 sq. ft.	1200 sq. ft.
Diameter of Drivers	5 ft. 7 in.	5 ft. 8 in.	5 ft. 7 in.	6 ft. 0 in.	6 ft. 0 in.	6 ft. 0 in.

"These oval boilers are applicable to any kind of engine with four, six or eight coupled wheels, as readily for freight as for passenger service.

"The shell shown has butt joints with double straps.


26

"Brunel's experiments showed, according to D. K. Clark, that strength of the solid sheet being taken as 100, the double rivetted doubled butt strap was 80, and the double rivetted lap 72, and that the latter was less for sheets more than 7-16ths of an inch in thickness, while the double rivetted double butt joint did not change for thicker sheets. The increase of strength is therefore, 11 per cent. over that of the double rivetted lap. I note this on account of the discussion which took place at Niagara last year."

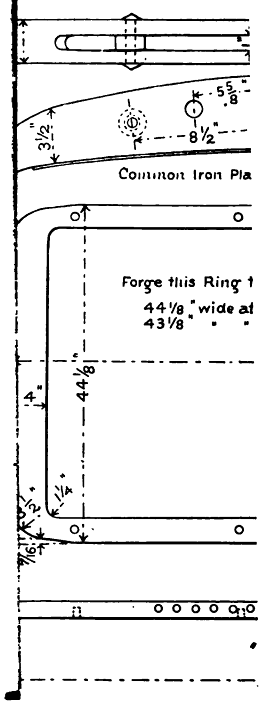
PLATE 11 is a boiler now being built by Reuben Wells, of the Louisville and Nashville Railway for a 20x24-inch cylinder Consolidation engine.

It is the Belpaire type, and designed to carry 150 pounds pressure per square inch.

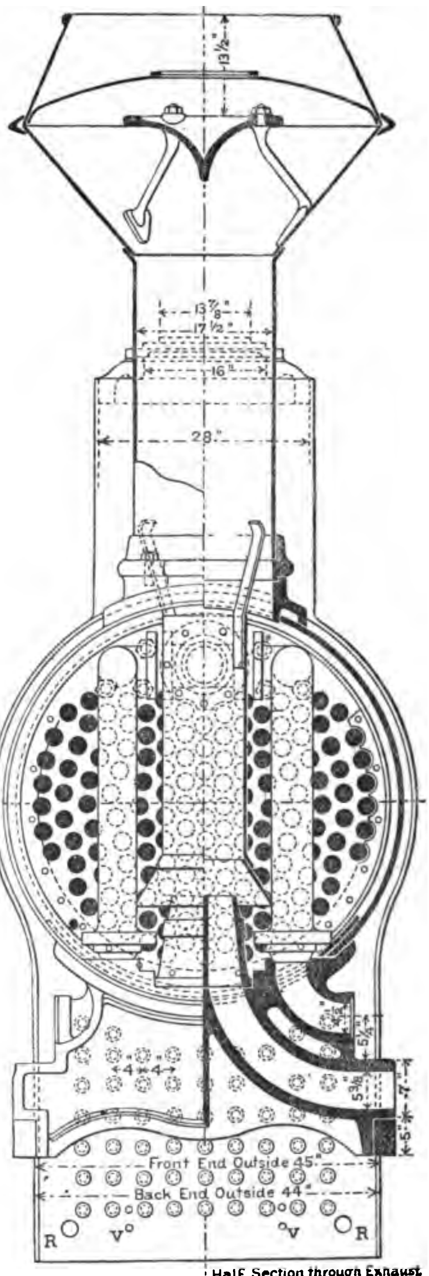
It is 60 inches in diameter, and made of steel ½-inch thick in cylindrical part. Longitudinal seams are welted and all cross-seams double rivetted. Crown sheet slopes backward one inch to the foot. Fire box is 9 feet long, 210 2-inch flues, 11 feet 5 inches long. Crown and top sheets are parallel and 23 inches apart. Brick arch on four pipes, and nuts on crown-bolts in fire box. Water space at the bottom, on sides and back, 3½ inches, front 4 inches, top 5½ inches on sides and 3½ inches back. Stay-bolts 4½ inches between centres. Crown bolts 4¾ inches to 5 inches centres, and 1 inch in diameter. Back sheet stayed by four pieces of 3x½-inch angle-iron, and 1½-inch round rods, upset at ends to take 1¾-inch nuts on the outside and passing forward between vertical and cross rows of bolts to shell of boiler.

PLATE 12 is a boiler designed by F. W. Webb, of the London and Northwestern Railway, for use in his compound express passenger engines, and may be best commented on by quoting his letter accompanying the drawing.

"In compliance with the request contained in your circular letter of March 17th, I now have pleasure in enclosing you a blue print tracing, illustrating our latest practice in locomotive boilers. This is the form of boiler we are using here, and is the form of boiler I am putting in my compound express passenger engines, and also in the six-wheel coupled Goods engines which we are now building for use on this railway, and I am sending photographs of both these



5 5/8"
3 1/2"
8 1/2"
Common Iron Pla
Forge this Ring 1
44 1/8" wide at
43 1/8" " "
44 1/8"
4"
1 1/4"
1/2"



Holes R for Mud Plugs.
" V " Damper Lugs.

nsverse Section of Smoke-box of Boiler for Mogul Locomotive for Lake Shore & Michigan Southern Railway.—See Plate VI.

types of engines for your exhibition in Chicago, in June next, together with a lot of other photographs.

"The boiler in question is made of steel, and calculated to work to 150 pounds on the square inch. The internal fire box, however, is made of copper, as we do not find that steel will stand, with our intense combustion, long enough to make it commercially successful, as, if we make the box thick enough to last we find it gives way by fracture, and if made thin enough to stand it has to be renewed too often. You will observe in this boiler that I have endeavored, as far as I can, to give as much elasticity as possible between the outer fire box casing and the inner fire box, there being no rigid foundation rings either for fire hole door or for the bottom of the box.

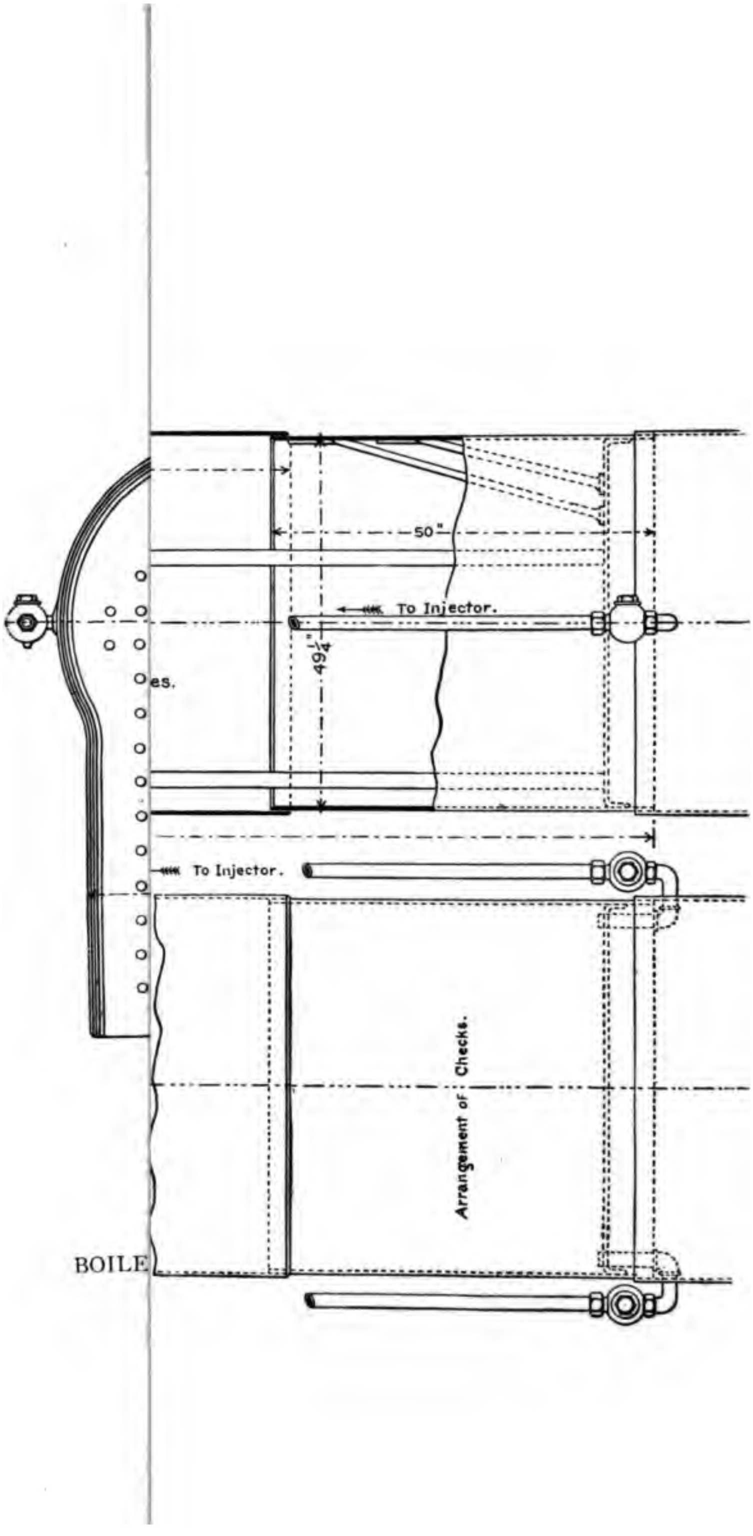
"The water space being carried entirely around in lieu of the usual ash pan, which not only gives this freedom of expansion, but at the same time prevents the lodgment of dirt on either leg of the fire box where the combustion is most intense. We find in practice that the great bulk of dirt falls to the bottom and is easily blown out by the ordinary blow-off cock.

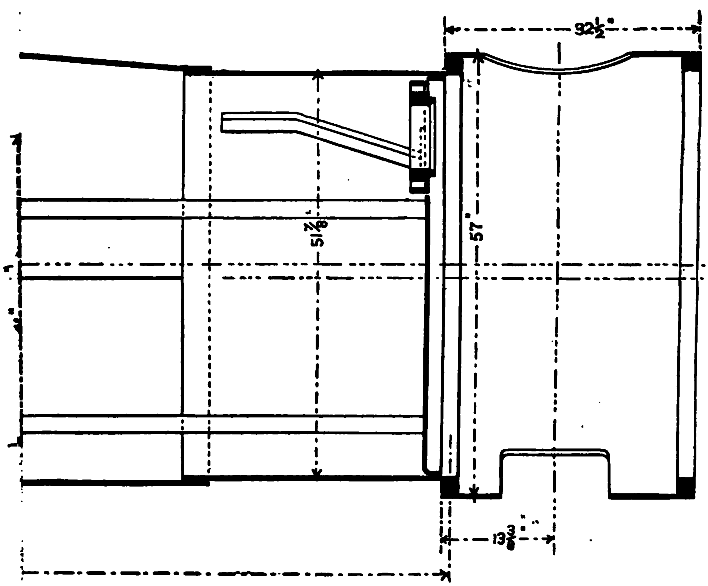
"Our roof stay bars are made of steel, and are slung up with slings between two sets of angle-irons, rivetted to the shell of the boiler, and the fire box top is bolted to these roof stays as shown, and they are easily removed when they require to be taken off for cleaning, but with the care we have taken with our water supply we very seldom find it necessary to do this.

"The tubes for these boilers are made of what we call in this country 70 and 30 mixture, that is 70 of copper and 30 of spelter.

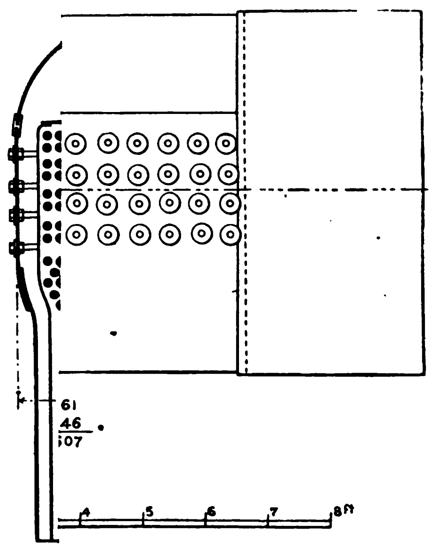
"The shell of this boiler is 48 inches in diameter at smallest ring, and has 198 flues, 1⅞ inches in diameter and 10 feet 2½ inches long. The fire box is 57 inches long and 41½ inches wide, and has brick arch with bearing on side sheets. The chief peculiarity of this boiler lies in continuing the water space entirely around and using the space between the grate bars and the bottom of fire box shell as an ash pan.

"This mode of construction is frequently adopted for portable and stationary engine boilers of the locomotive type in this country, and if the internal sheet, forming the bottom, is not injured by the corroding effect of damp ashes from impure coals, there is certainly


50"
To Injector.
49¼"
es.
To Injector.
Arrangement of Checks.
BOILE



hracite Coal by J. E. Wooten, General Manager.



61
46
07
4
5
6
7
8 ft

THE PRESIDENT—It seems to me that we would not probably have any more in then than now, and while this subject is up it seems to me it would be well to go on with the discussion, or close it. If no one has anything to say, the debate can be closed at any time on motion.

MR. J. O. D. LILLY—Have any of these gentlemen presenting these boilers ever made any experiments as to the amount of water evaporated for the amount of fuel burned? I have heard some conversation among some of the gentlemen, and I think some present here have been making some experiments that would be interesting to the Convention if they could be called out.

MR. SPRAGUE—In the engines that I have been building, I make my crown sheets all in one piece, avoiding seams and running the crown bars longitudinally on most boilers; but sometimes we stay-bolt them.

Mr. Sprague moved that the discussion be postponed until the next morning. The motion was seconded.

MR. J. N. LAUDER, Mexican Central Railroad—I should be inclined to oppose that motion. Our time is somewhat limited. It would be difficult for us to do our necessary business and do it properly, with what outside arrangements our friends have made for us; and we have had this report read and illustrated, and now it is up for discussion, and I think the proper way is to finish it. It is part of the business at the present time. If anybody has anything to say on this boiler question, I think they could say it now at this session. I think we had better close this business up and get through with it. I see no reason why we should postpone it, as we are as competent at this time to discuss this subject as we shall be at any future time. I do not think that there is very much to be said on this boiler question. It has been discussed year after year, until it is thread-bare and I am utterly opposed to postponing this discussion to any future time.

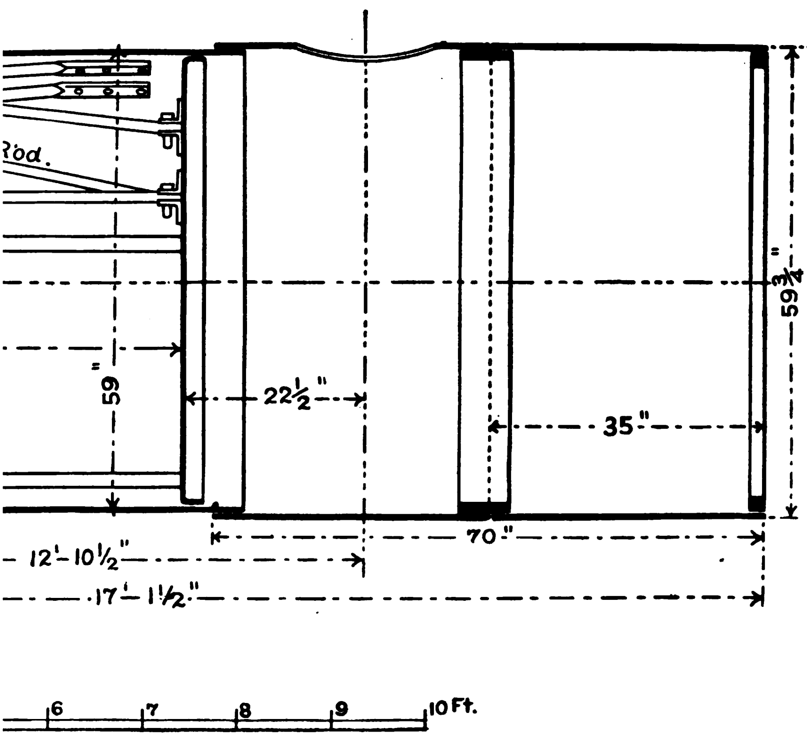
The motion to postpone the discussion was lost.

MR. LAUDER—I would now ask whether those water tubes give any trouble in maintaining them?

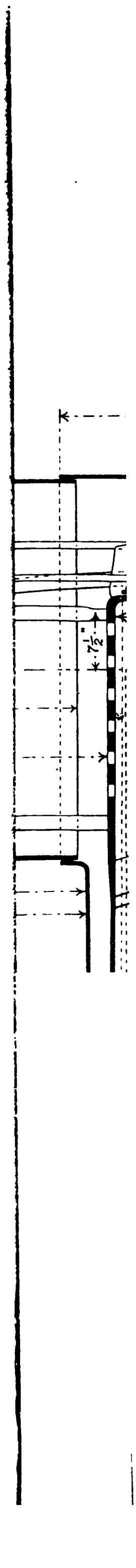
MR. WILDER—We have been using that same construction, and for a long time we have had very little trouble with our water tubes, but after they have been in from 2 to 3 years, I find that they fill up, and we have had to put in plugs opposite to them and keep them bored out. Whenever we wash the boilers out we can take out those plugs and also scrape the tubes. I found some of them stopped up so that there was not over an eighth of an inch hole.

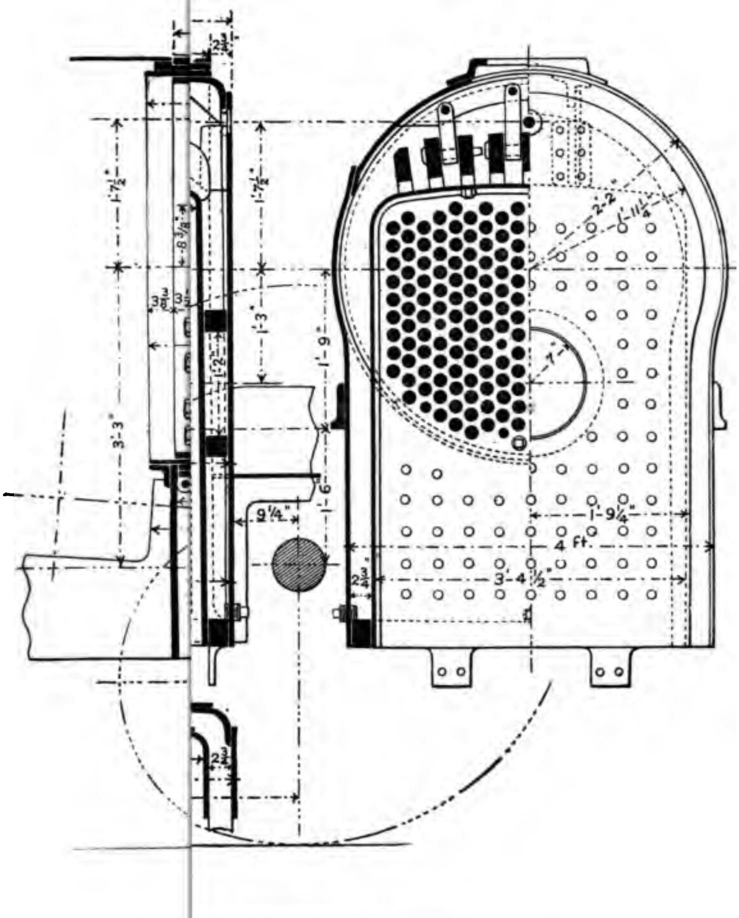
MR. LAUDER—Were they filled with sediment?

MR. WILDER—I had no analysis made of the deposit, but it seemed to me to be sediment of mud, and some of the deposits of lime. It



euben Wells, Superintendent of Machinery.


7½"



Locomotive Superintendent.

area of the top of the chimney, and thus affords a very free egress to the gases, whilst it completely stops the sparks. When it is in its place on the chimney the wire stands perpendicularly to the horizon, and the sparks, after striking against it, finally fall down and nearly leave the passage free, and it is hoped that by making a few small holes in the lower plate of the cap near the wire, to admit a small portion of atmospheric air, these sparks will burn and thus save the trouble of cleaning out the cap by hand. The cap should be so nicely balanced as to turn freely to the wind. At the same time, it should fit so closely to the chimney as to let in as little air as possible into the cap, for every particle which thus enters diminishes the draft."

The patent granted 27th August, 1835, to A. C. Jones, shows a hood of wire gauze and a cowl, the gauze being extended over the top of the stack, and having on one side a cowl into which the motion of the locomotive induced a current of air, and on the opposite side was a tube leading to the bottom of the smoke chamber, into and down which tube the sparks were driven by the air current.

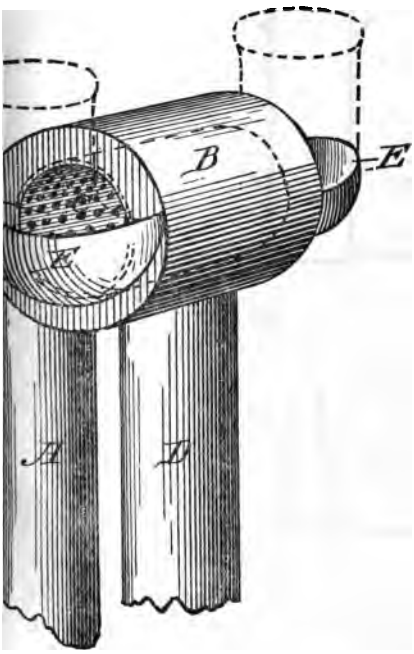
H. C. Wiatt, 15th October, 1835, patented an outer shell or jacket completely surrounding the stack, and covered with a fine wire gauze, which arrested and dropped the sparks into the annular chamber between the stack and the jacket.

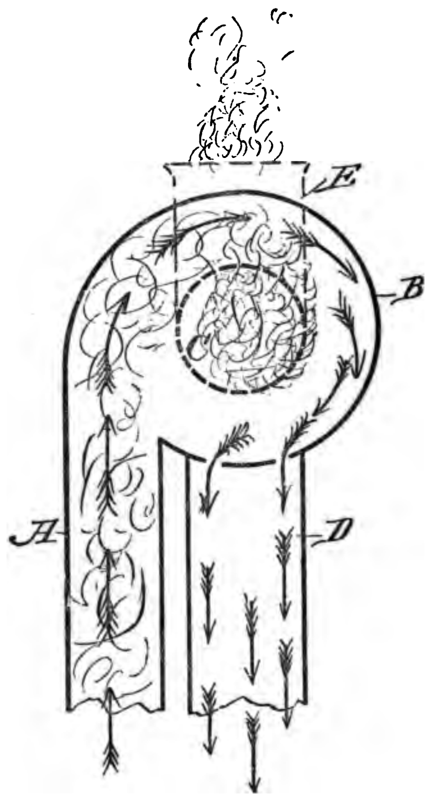
As long ago as July 28th, 1838, W. S. Montgomery patented a deflector and pipe for arresting the sparks and carrying them back to the ash-pan, Fig. 1 being a side sectional view, and Fig. 2 being a front sectional view.

In the Montgomery stack the sparks are passed down the duct into the chamber at the bottom of the stack, and thence to the ash-pan by their own momentum, by the inclined partition in the chamber, and by gravity.

In the W. C. Grimes patent of June 7th, 1845, we find an early illustration in a practical form of separating the cinders and sparks from the smoke and gases by centrifugal force.

A is the stack with a circular or scroll shaped top; *B*, which deflects the sparks into the tube *D*, where the gases and smoke pass through the cylindrical screen *C* and out through the short side flues *E E*.

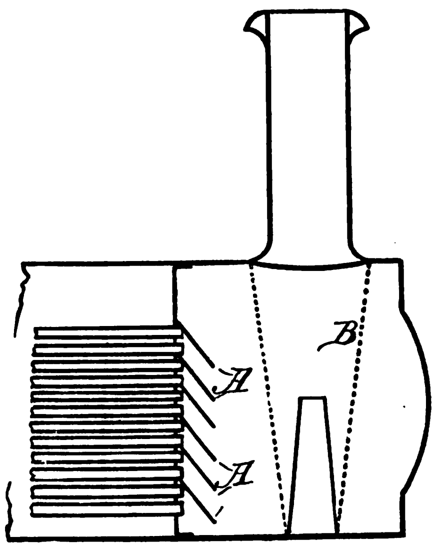




In the T. Newhall, Jr., patent of 27th January, 1838, the smoke is conducted from the boiler through a bent tube or goose neck with a downwardly open mouth, into the smoke-stack beneath, which is a water reservoir into which the sparks are thrown.

By reference to the patents of N. Turbott, Dec. 7th, 1839; Raeney & Naglee, Dec. 28th, 1839; W. H. Hubbell, 26th June, 1841, and

E. May, July 28th, 1859, it will be seen that putting such deflectors, screens, etc., between the smoke-stack and the smoke-box, and also lower down in the smoke-box and surrounding the exhaust nozzle with them, and putting them in front of the flues, were early suggestions in the progress of this art. The devices shown in the following sketch, in which *B* is an inverted cone of perforated metal or wire gauze, and *A A* perforated deflecting plates, have long been well known and public property.



So also the principle of promoting combustion by injecting commingled air and steam into the fire boxes, has long been known in connection with this art, practical devices therefor being shown in the patents of F. X. Wurm, of November 14, 1848, and of C. Burkhardt, of June 5, 1849—the patent of Wurm being an interesting essay upon this subject.

We here insert as of historical interest a print of a partial collection* of old smoke-stacks made by the Baldwin Locomotive Works, which was made for the purpose of defending a suit which was not tried. (For additional details as to this early history, see a paper by J. Snowden Bell, Attorney, etc., in Jnl. Frank. Inst., Vol., cix. p. 1).

*The dates attached to the several figures are not authentic.

Continuing this brief historical summary of some of the elements of the Spark Arresters, which are now calling for attention, we find that a spark-box under the smoke-box having a valve to discharge its contents upon the track, was patented to R. A. Wilder, in 1854. (See Jnl. Frank. Inst. 3rd Series, 1857, p. 414).

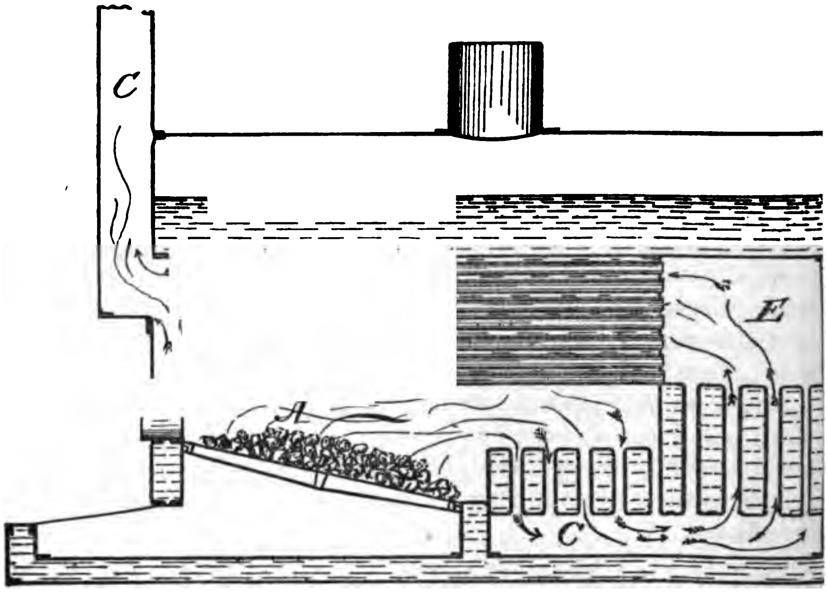
With reference to additional combustion chambers: Between 1852 and 1854, in England, and from 1852 for a longer period in the United States, inventors were active in attempting to promote combustion and arrest sparks by inserting a supplemental combustion chamber with the necessary supply of air, and with a man-hole in its bottom, midway of the boiler between the fire box and the smoke-box, and connected with them by flues or by a perforated partition or water wall. The first patent upon this construction was No. 8,742 granted 17th February, 1852, to J. Millholland, and a similar construction is shown in patent No. 18,467, granted 30th October, 1857, to W. G. Norris, with the additional combustion chamber located within a few inches of the fire box. Several English patents, which have also expired, show the same or substantially the same construction. (See Burgh, on boilers, pp. 258, 259, 262 and 272.)

Patent 92,952, granted 27th July, 1869, to C. H. Franklin, Jr., which will expire 27th July, 1886, shows a similar combustion chamber in combination with return flues. In the following drawing of the Franklin patent, C E and C represent the three combustion chambers.

In all of these constructions the grate surface seems to be contracted.

We shall here dismiss this part of the subject, for while we have no record of experiments with these constructions, or of the reasons for their abandonment, we suggest that they are impracticable because of impairing the directness and strength of the draft, and much simpler devices and less radical changes are necessary to accomplish spark arresting. What the merits or demerits of these and more recent constructions may be in the use of super-heated steam, it is not our present province to discuss.

It would be interesting but hardly profitable to review the lines which inventors have pursued in attempting to extinguish sparks, first by pulverization or disintegration; and second, by plunging them into water; and third, by jets of water, steam or air. To



Franklin 1869

pulverize the sparks is wasteful and disagreeable, and if not entirely successful is dangerous, for it does not require a very large spark, so quick is its transit out of the stack, to retain its fire long enough to ignite cotton or hay, either on the train or on the roadside. To pulverize the sparks is disagreeable, for the dust is often precipitated on and into the train. It is also wasteful, for if they do not contain enough fuel to be worthy of being burned again in the fire box, they are needed upon the track. The discharge of the cinders on the track, may, and in many devices does, involve a jet of commingled steam and water from the boiler, which effectually extinguishes them.

Conveyance of sparks, after they have been caught, to the rear of the train, to the ash-pan, to the fire box, and to the bottom of the smoke-box, are the respective dispositions to be made of them, which have been advocated in the order named by inventors.

The Montgomery patent, of 1838, already referred to, shows a plan of conveying the sparks to the ash-pan, partially by the force of the exhaust.

Longmire & Brooke, in 1840, patented an impracticable combination of a feed-water heater and spark arrester, which used the exhaust to drive the sparks into a chamber beneath the fire box.

We do not propose to attempt a review of the history of the devices, which have formed the subject matter of an interesting and unsatisfactory patent controversy between the Matthew, Griggs, Pike, Berney and Hawkes and Paine patents, upon double and variously divided stacks, and upon conduits to the rear of the boiler, which are actuated by exhaust steam, or by variously induced currents of atmospheric air, which controversy commences with the Matthew's patent, of 1840. In our opinion the running of a pipe from the top of the stack directly to the top and outside of the boiler and thence to the fire box, is as ungainly and unnecessary as the old Blood patent of 1857, which has a circular fan stuck in front of the smoke-box door to induce currents of air into the spark-tubes. Suffice it to say, that the arrangement of the tubes to convey the sparks after caught, either to the fire-box, or to the track, is one easily made after the other elements and combinations of a desirable spark arrester shall have been determined. Our remarks concerning pulverizing the sparks will in general

apply to the devices both old and new, intended either to carry the sparks along the top and to the rear of the train, or to carry them so high into the air that they shall not reach the train, and we exclude the same from our further consideration.

Herewith, as an appendix to this report, your Committee submits the drawings, and in some instances the specification of one hundred and fifteen patents, intended to be illustrative of the above brief and imperfect historical outline, indexed and arranged as follows:

Exhibits	1–37	To illustrate different forms and combinations of netting and cones.
"	38–87	To illustrate extinguishing and pulverizing sparks by centrifugal force by plunging into water, and by jets of air and steam.
"	88–107	To illustrate the conveyance of sparks after having been arrested.
"	109–115	To illustrate extended smoke-boxes with and without screens and deflectors.

Such a classification is of course unsatisfactory without repeating as has not been done, several exhibits in several classes. For instance, the Taylor patent, Exhibit 28, has been put in the first class, while it might as well and perhaps better have been included with the exhibits of extended smoke-boxes.

It would be well worth the while of any who may study this report, if not able to more thoroughly examine the exhibits in the appendix, to carefully study the following:

Davis, No. 8; Wiser, No. 10; Wootten, No. 24; Dun & Havener, No. 27; Taylor, No. 28; Schemerhorn, No. 29; Cook, No. 36; Stevens, No. 44; Ferrand, No. 55; Groesbeck, Nos. 59, 62 and 63; Prusmann, No. 68; Shaw, No. 70; Griggs, No. 91; Berney, Nos. 95, 101 and 103, and Hill, No. 114.

The matter of extending the smoke-box, or of adding a separate compartment in front of the smoke-box, for the reception of sparks, is one of importance. We have been informed of uses of such extensions, prior to the date of any patent showing them. The following selected patents will briefly show the record history of these devices.

Thompson (Patent No. 28,520, of 1860) conceived the erroneous idea, that if the smoke-box was extended beyond the smoke current, the sparks and cinders would be deposited in the smoke-box, forward of that boundary, by gravity alone.

Smith (Patent No. 191,187, of 1877) extended the smoke-box, and placed downwardly inclined deflecting plates therein to lead the sparks into a depositing box below the smoke-box.

Hovey (No. 38,111, of 1863, Exhibit 110) is probably the first to show a combination of an extended smoke-box with a screen.

Much was claimed for it by the inventor, but we are indirectly informed, that its use on the Cleveland & Pittsburgh R. R., in 1863, and thereafter, was not successful, draft being suppressed, and the smoke-boxes becoming unduly heated.

Congdon (No. 43,898, of 1864) used a screen horizontally across the entire top of the smoke-box and surrounding the exhaust nozzle and a jet of steam discharged down through an opening in the bottom of the box through which the sparks are discharged. He designed to effect a free discharge of the sparks from the smoke-box and at the same time prevent an upward rush of air into the smoke-box through the discharge aperture for the sparks.

Cromwell (No. 243,111, of 1881) shows a modification in the construction of the netting, and also the use in connection with the netting diaphragm, or horizontal partition of a depending perforated basket surrounding the exhaust nozzle.

Kowalski, et. al. (No. 247,256, of 1881) show a deflecting sheet in front of the flues, in connection with a horizontal sheet-iron diaphragm, wire netting, and draft regulator. The deflecting sheet has longitudinal movement to and from the ends of the tubes.

Hill (No. 260,753, of 1882) shows a deflector secured at the top to the flue head, and at the sides to the smoke-box, and inclined outwardly and downwardly from the flue head, so as to present a discharge space of gradually increasing area for the products of combustion, as also a screen extended horizontally from the forward end of the smoke-box to the rear of the exhaust nozzle, and then inclining upward to the crown of the smoke-box.

Millholland (No. 271,255, of 1883) exhibit 115, uses in connection with the extended smoke-box, a partition extended upwardly and forwardly in advance of the flues, and terminating near a hori-

zontal diaphragm, which reaches from the front tube sheet to a point beyond the said diaphragm, and connects with a horizontal screen or netting.

The J. K. Taylor device will be hereafter referred to.

On examining the annual reports of this Association for data for this review, we find that in all its reports and discussions no special report or discussion has been had on this particular subject, although, in the several reports of the Committee on Boiler Construction and in many discussions it has been referred to. Much has been investigated and reported upon as to the proper construction of the fire box, smoke-box and smoke-stack for the purposes of draft, and very satisfactory results have been arrived at, as to the introduction of air through hollow stay-bolts for the purposes of combustion. (See Mr. Higginson's report, Annual Report of 1878, p. 96.) The most intelligent report, heretofore yet made upon our present subject, forms a part of the report of the Committee on Boilers printed in the Ninth Annual Report (1876) at page 89, and is very interesting as to the results then arrived at. The Committee found that to reconcile the amount of exhaust desired for the purposes of a draft, with a more or less complete arresting of the sparks, different forms of stacks must be used with different fuels, and tried careful experiments with the following device: The lower part of the extension of the smoke-box was extended down as far as the truck would permit to be used as a reservoir for the sparks. A plate of sheet iron extended from immediately above the tubes horizontally to the exhaust pipes, and fitted closely around the steam pipes, the nozzle of the exhaust pipe extended a few inches above it, and a wire netting extended from the forward end of the sheet-iron plate horizontally about thirty inches, and then vertically to the top of the smoke-box. Using Ashland (Kentucky) and block (Indiana) coal, 88 per cent. of the weight of which was found to be combustible, the committee found that with this device 14 per cent. of the weight, and 25 per cent. of the volume of the coal put into the fire-box was wasted. One of the conclusions found by this committee, not in its experiments with the device described, but in its general experience, is as follows: "*That ten per cent. of the fuel used by engines burning bituminous coal in this country is wasted in the way referred to.*"

Another estimate of this waste taken from the specifications of a comparatively recent patent, granted to a locomotive builder is, that nearly *fifty-five per cent.* of the fuel used prematurely escapes unconsumed in the condition of gases and ignited sparks.

We have dismissed the matter of additional and intermediate combustion chambers, and the question of the introduction of air into the fire box to promote combustion.

We also now dismiss the collateral subject of smoke consuming with the recommendation with the devices for that purpose, involving a commingled jet of super-heated steam and air, which are well known to the members of the Association, should be examined.

It is proper here to say, that your committee has indirectly learned that quite interesting results have been very recently attained on the C. & A. R. R. from a short and perhaps not sufficiently long use of hydro-carbon oil and super-heated steam as fuel, under the Byron Sloper patent, of June 20, 1882.

CONCLUSIONS.

I. The question how to construct a successful spark arrester will be effected considerably by the question, "What is to be done with the sparks when arrested?"

It seems apparent that this will in turn depend upon the composition of the fuel used. One kind of coal, under the most favorable conditions for steaming, will discharge, we will say fifteen and another twenty per cent. of its weight through the stack. Of this fifteen or twenty per cent. in the one case, say thirty, and in another case say seventy-five per cent. will be burned if returned to the fire box. The disadvantage of having dead matter in the fire box with our comparatively small grate surface is so great that this per cent. of the residuum of the first combustion must be great to warrant its return to the fire box. Although we are told by some master mechanics of experience and ability, that none of the product which passes through the stack, on their roads, could be burned if returned to the fire box, there are doubtless instances in which such return would be advantageous, though they be comparatively few. Careful examinations on each road of the solids discharged through the stack should be made. Such examinations, if carefully and frequently made, would result in other operative

benefits, besides deciding whether what is now discharged through the stack should be returned to the fire box, and would astonish many as to the commercial value of the waste that is now permitted at *that* point.

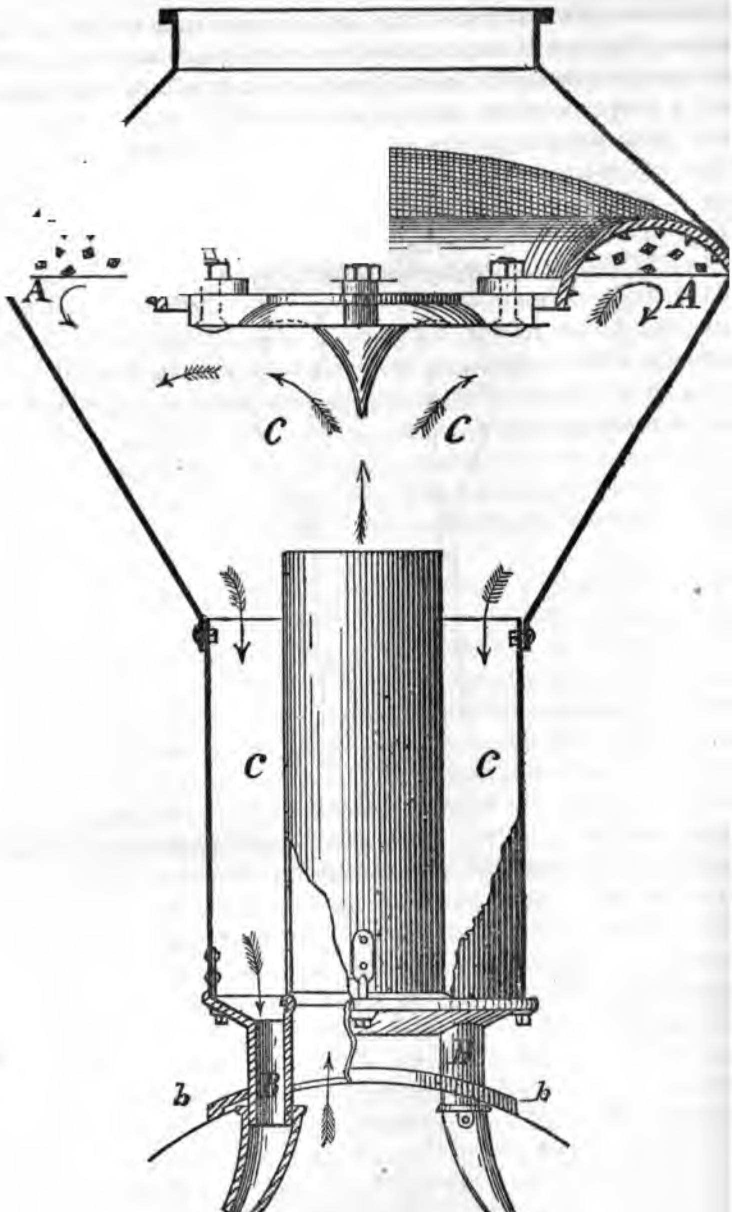
If it is desirable to return the sparks and cinders to the fire box, we then recommend that the return pipe should lead from the lower portion of the smoke-box; that careful experiments be tried with both currents of air and jets of steam through the return pipe, the discharge into the fire box being just below the fire-brick arch or water-leg.

II. While the character of the coal used and the value as fuel of the residuum referred to, is the first question to be ascertained by careful experiments, the arrangement adopted therefor, should and may be so constructed as to work either with or without the spark arrester proper, for the same engine must at different times use essentially different qualities of fuel. The return pipes to the fire box should run from, and be at will detached from the depository when it is not desirable to use the return pipes.

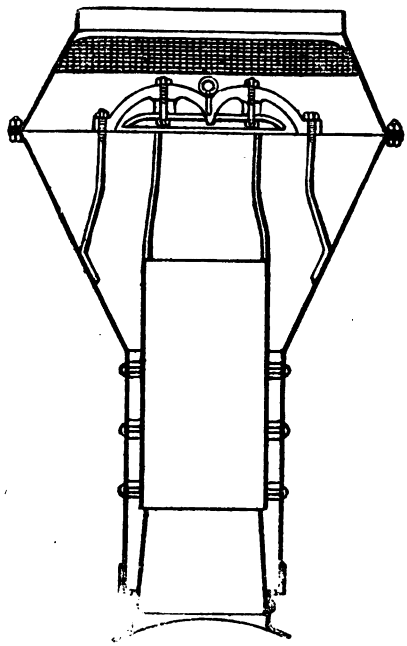
III. The first requisite of a spark arrester is, that it should not interfere at all with any draft desired or possible. We have seen that spark arresters were first put upon the top of the stacks, then at the bottom of the stack, and now in the absence of any demonstration, by either experience or experiments, opinions seem to be divided between placing the same in the smoke-box, or replacing the same upon the top of the stack. Your Committee has not seen any arrangement located at the bottom of the stack which commended itself as worthy of experiment. We are also of opinion that to locate a successful arresting device in the smoke-box itself, without materially enlarging the box, would fatally effect the draft. This will be spoken of further on. It must be conceded that the common cone and screen, *as heretofore generally used*, is a practical failure to prevent the nuisance, waste and danger complained of. This, however being furtherest from the exhaust and the tubes, seems to be the natural location, and in our opinion a netting and a metal deflector can be so arranged at this point as to effectually prevent the discharge from the stack of anything but gases and without materially impeding the draft. The proper height of the apex of the inverted cone or deflector and its proper diameter, with

reference to the diameter of the inside pipe or stack proper, and its proper shape of face or underside so as to immediately precipitate the sparks out of the line of upward draft, should be ascertained, and a proper conduit and receptacle should be added, to at once take them away from this agitated point, and beyond the possibility of their choking the stack or the smoke-box, and beyond the possibility of getting into the exhaust nozzles and thence into the cylinders when steam is shut off or the engine reversed.

In addition to the construction of cones and deflectors for the top of the stack, shown in the Appendix, we add the following, which has been in use on the Atchison, Topeka & Santa Fe R. R. for upwards of three years with, as we are informed, no material detriment to the draft. This stack, we understand, is the subject of two or more patents.


A
A
C
C
C
C
B
B
b
b

We have also heard that favorable results have been arrived at, and with no impediment to the draft on railroads in Iowa, in the use of the Hawksworth Spark Arrester, (Patent of November 11th, 1879,) of which we also insert a sketch.



The exhaust drives the sparks and cinders against a peculiarly shaped cone, by which they are deflected to the sides of the upper part of the stack, and from thence they fall into an annular chamber in the straight part of the stack. The inside pipe or the stack proper is divided horizontally into two pipes, the bottom pipe tapering upwards, and thus leaving a space through which the sparks and cinders are drawn from this annular chamber into the inside stack. Sparks and cinders are thus driven continuously out of the top of the stack, against the cone, into the annular chamber and again into the bottom of the stack until they are pulverized, and pass out through the netting at the top of the stack in a condition which will not set out fires.

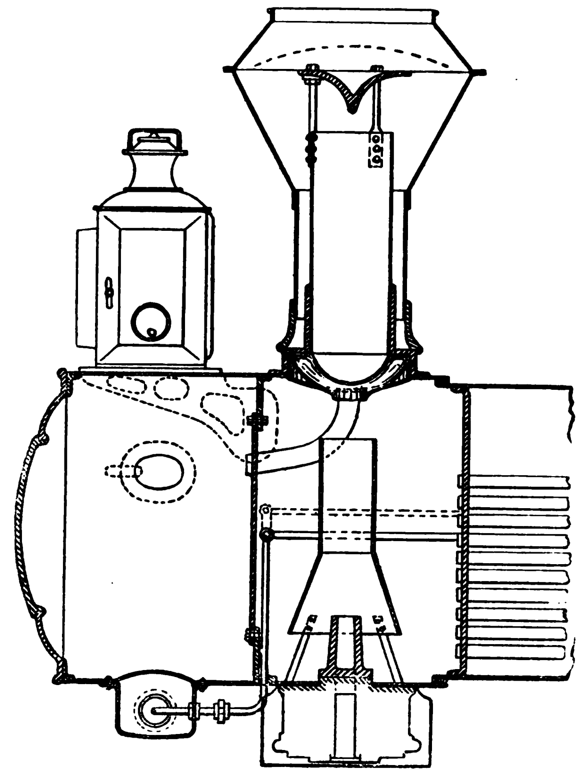
IV. If, in the experiments to be tried, the arrester be placed at the top of the stack, we recommend that the double diamond stack be used, and that the annular space between the stack and the outer shell be used as a conduit (not a reservoir) for the sparks.

V. While extending the smoke-box is comparatively of ancient origin, it has been revived within the last five years, earnestly insisted upon, and as savagely opposed. The additional cost of construction and maintenance, and the increased weight thrown upon the truck, and the more trivial objection that it needs cleaning, are of minor importance and do not deserve consideration, if such extension serves any useful purpose and accomplishes any valuable result. The more serious objection was made by Colburn, Clark, Le Chatelier, Bell and others, that the dimensions of the smoke-box should be, on principle, as limited as possible for the reason that, whether the force of the exhaust there be either suction or propulsion, or both, the amount of air to be dilated, rarified or lifted should be as little as possible. This objection was directed when made to an extension of the smoke-box of seven feet, and contains a principle which may limit this extension, but does not necessarily forbid it. To say that the extension of the smoke-box to six or seven feet impairs the necessary force and effect of the blast is not the equivalent of saying that the boxes heretofore in use cannot be enlarged at all without such bad results. The volume of the smoke-box and the directness of the draft from the flues to the stack should be arranged with nicety.

VI. With the idea that if the smoke-box is enlarged sufficiently to accommodate the accumulation of a round trip, the volume of the box will be too great at the commencement of the trip, and too small as the sparks shall subsequently bank up in its front, and with the fear that if deposited here the sparks will be drawn down the exhaust nozzles, inventors have suggested two plans: First, a spark-box extending beneath the smoke-box as far as the truck will permit (see Congdon and others mentioned above), with a jet of steam, which shall not interfere with the exhaust, to drive the sparks into this box; and, second, a separate compartment in front of the smoke-box proper, into which the sparks are conducted from the annular chamber in the stack. Of the latter class, the J. K. Taylor

device, with which, in different forms, extensive experiments have been made at the East, forms a fair illustration.

We insert a drawing of it as now offered to railroad companies.



VII. Whichever arrangement of a reservoir for the sparks be experimented with, we suggest that unless the return pipe to the fire box be used, the discharge opening from the reservoir shall be under the control of the fireman while running, so that he may discharge the cinders upon the track at any time, as desired by the road master, or at regular dumping places, as may be indicated by signs upon the track. It has been suggested that the deposit of the sparks upon the track in front of the smoke-box, while the locomotive is in motion, will result in their being precipitated upon the

machinery underneath the engine in a way that is not at all to be permitted. We are not aware of any experiments which have demonstrated this, or whether if such an evil exists, it could be cured by the use of an apron, without making the device too cumbersome or too expensive of construction and maintenance.

VIII. The different arrangements recently suggested for placing deflectors and netting in extended smoke-boxes, not having a separate spark chamber, are not at our command, further than as shown in the patent drawings herewith submitted, except the following which is a drawing of a smoke-box which we understand is about to be introduced on one of the Southern Roads.

IX. It is apparent that many of the different devices suggested involve the question of the best form and size of exhaust nozzles, which has been so frequently and fully discussed in this Association. We suggest also that a further consideration of the best form of petticoat pipe, with reference to procuring an equal draft through all the tubes, would be profitable.

It is hardly necessary to add that the Committee has not intended to intimate what may or may not be the legal patent relations between the devices herein mentioned, and we add the suggestion that these relations should be thoroughly examined when any device shall have been selected to experiment with.

We desire, in conclusion, to acknowledge our obligation to Mr. George H. Howard, of Washington, D. C., Solicitor of Patents, and Washington Examiner for the Western Railroad Association, by whom most of the data from which this report is made up was collected and largely digested.

In the hope that this imperfect review, these hurried suggestions, and the Appendix hereto will enable a future committee to properly prepare and carefully make some experiments which shall lead to early, right and valuable conclusions, this report is

Respectfully submitted,

H. B. STONE, *For Committee.*

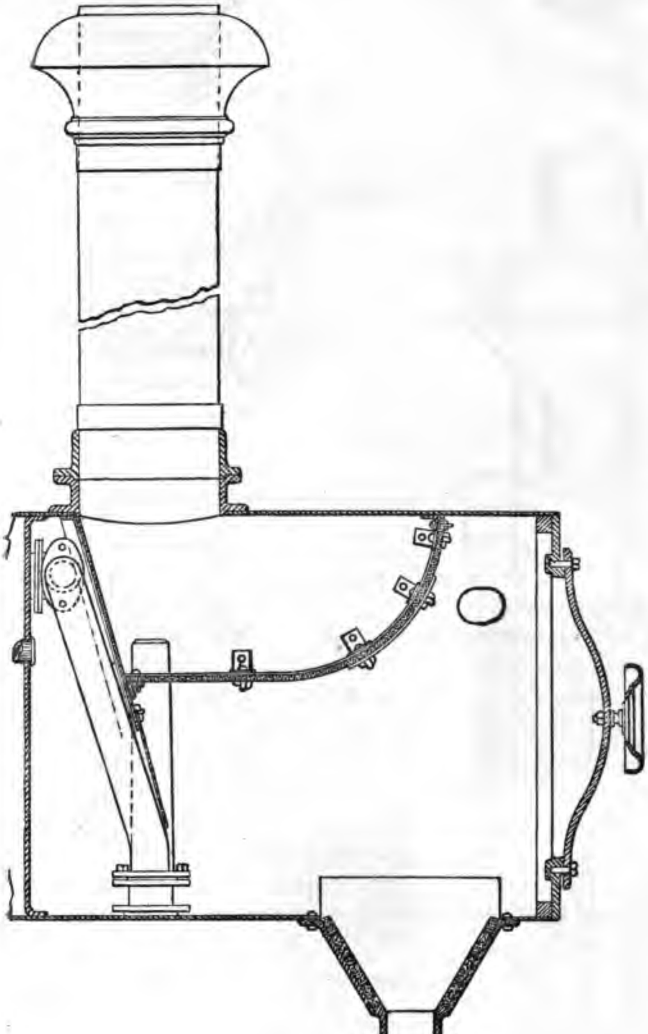
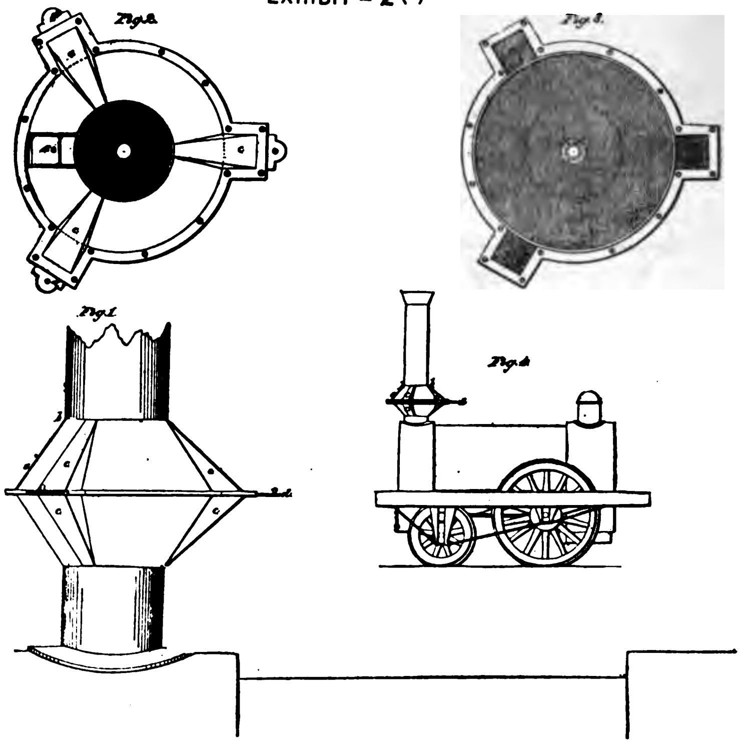
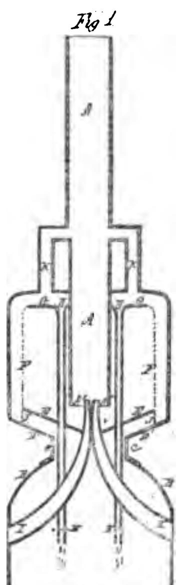


EXHIBIT – 2 (*)



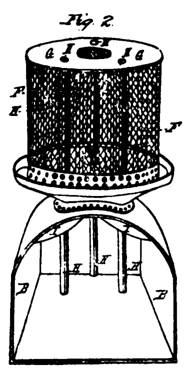
W. Shultz—Patented March 31, 1836.

EXHIBIT–3.

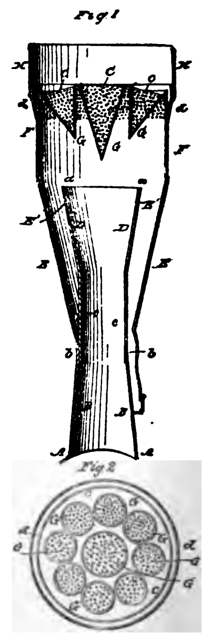


L. Phleger—Patent'd Nov. 25, 1839.

EXHIBIT–3.



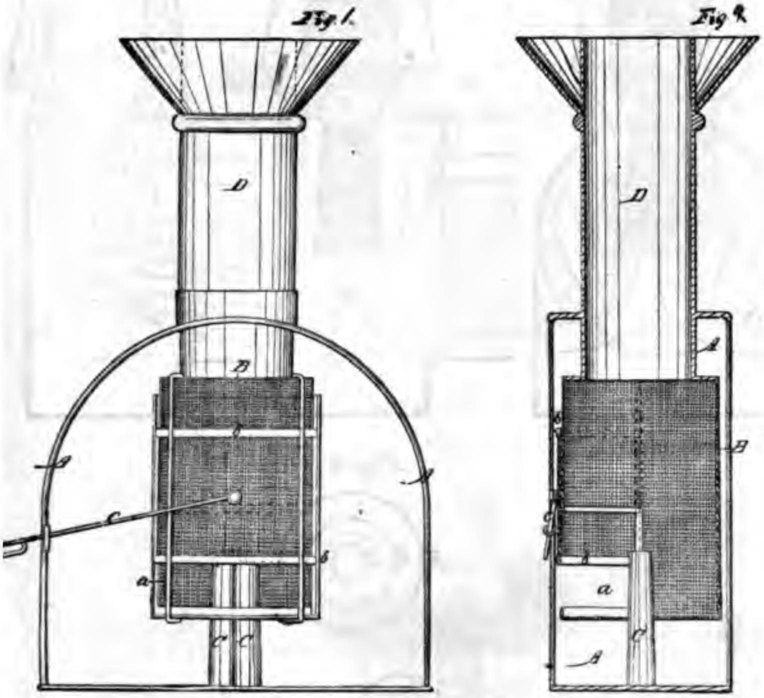
EXHIBIT–4.



Raney & Naglee—Patented Dec. 28, 1839.

*Exhibit No. 1 see page 94.

EXHIBIT.- 5.



E. May—Patented July 28, 1857.

EXHIBIT—6.

Fig. 3. Fig. 1. Fig. 2.

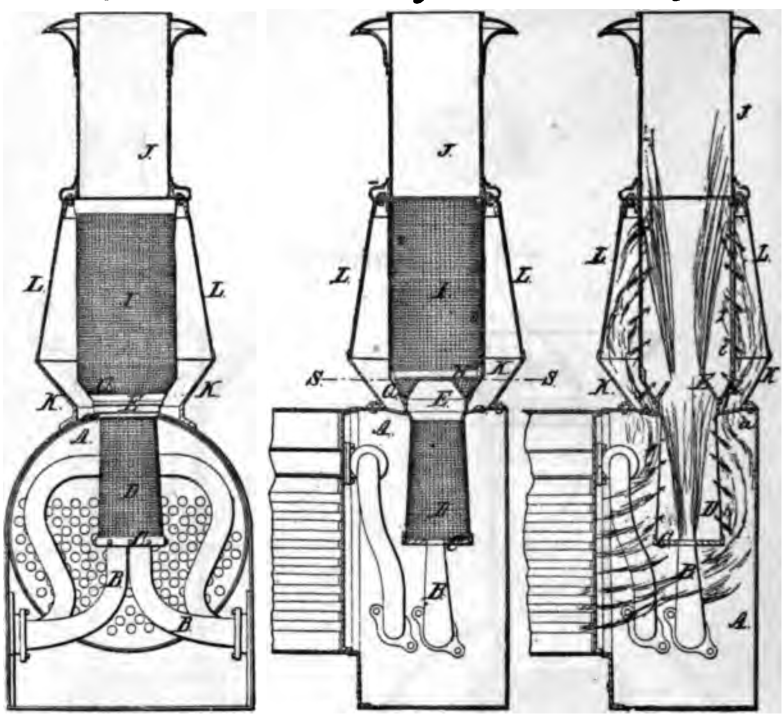
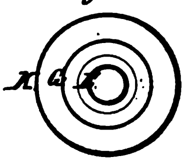


Fig. 4.



A. S. Sweet—Patented June 23, 1863.

EXHIBIT—7.

Fig. 1.

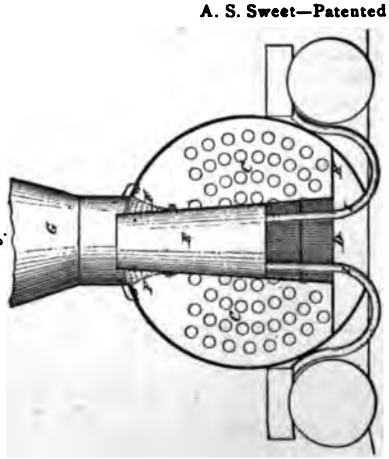
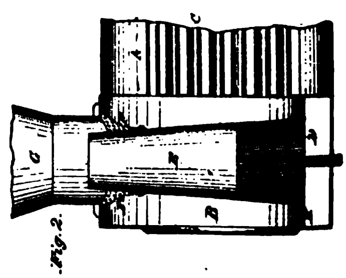
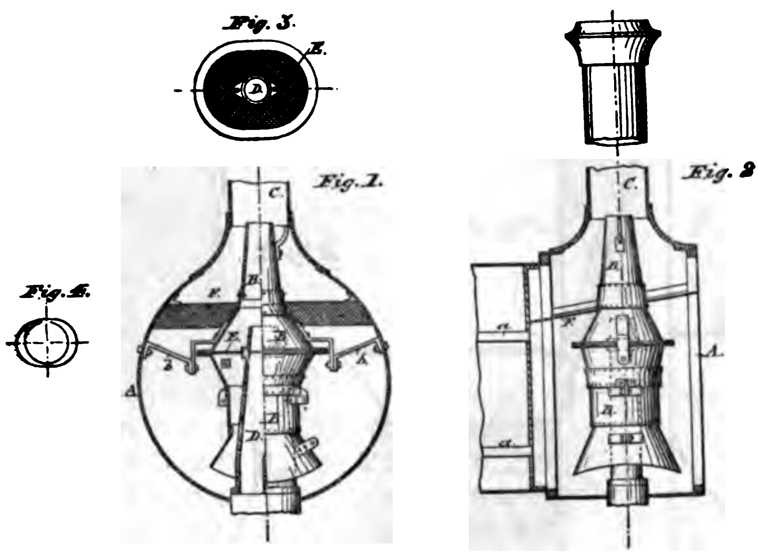


Fig. 2.



F. Kearney & L. F. Tronson—Patented December 10, 1872.

EXHIBIT–8.



A. Davis—Patented November 5, 1878.

EXHIBIT–9.

Fig. 1.

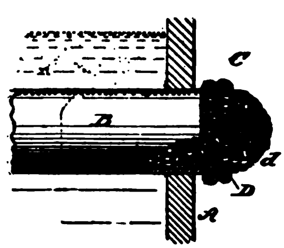
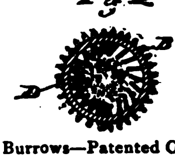
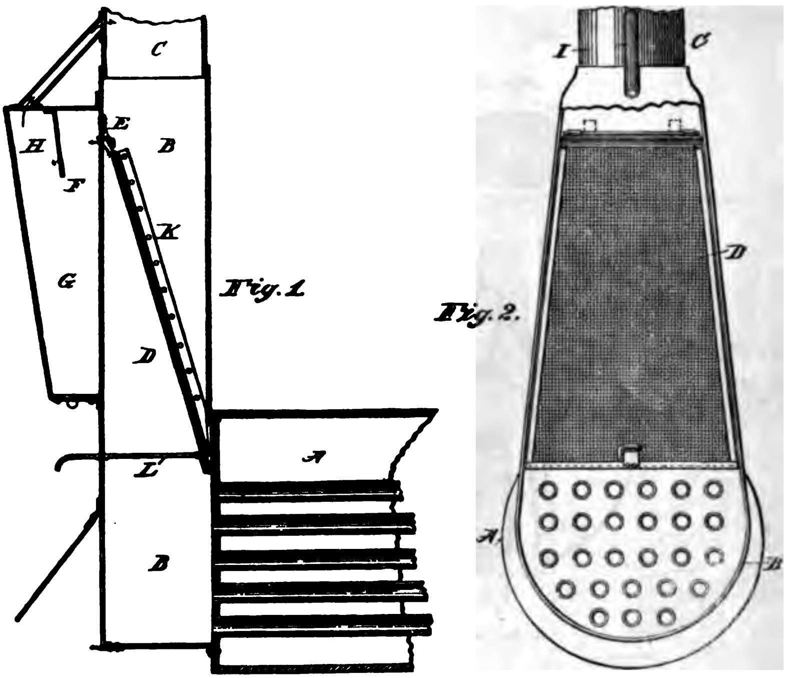


Fig. 2



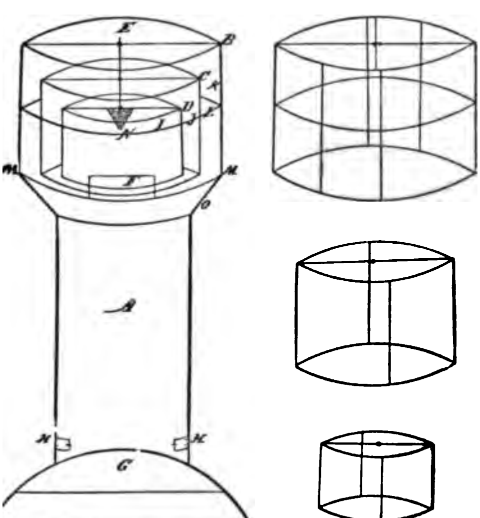
G. H. Burrows—Patented Oct. 11, 1881.

EXHIBIT-10.



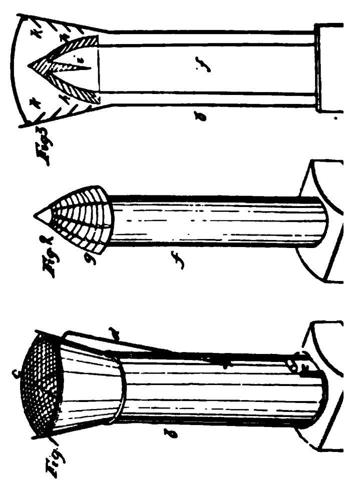
D. Wiser—Patented September 19, 1882.

EXHIBIT-11.



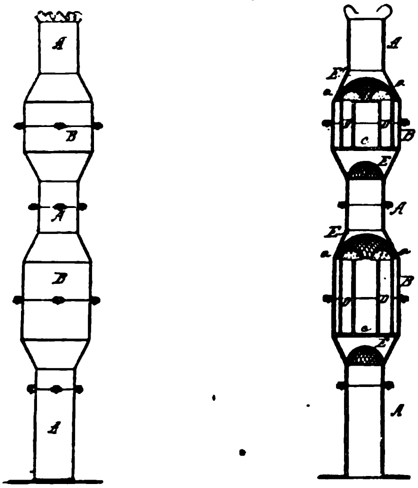
G. Holbrook—Patented November 23, 1835.

EXHIBIT-12.



W. Duff—Patented December 20, 1837.

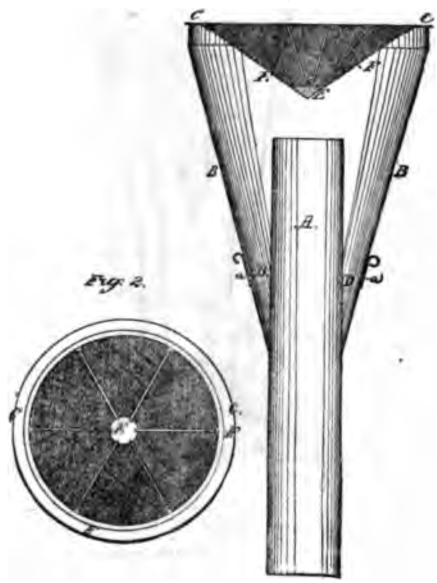
EXHIBIT–13.



J. Oberhausser—Patented February 24, 1838.

EXHIBIT-1–

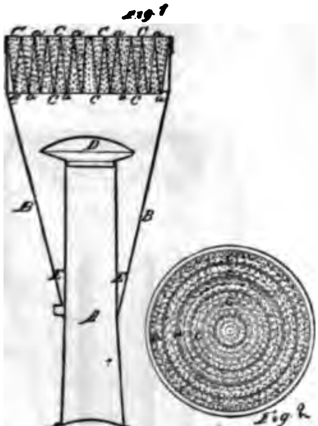
Fig: 1



B. Briscow—Patented December 15, 1838.

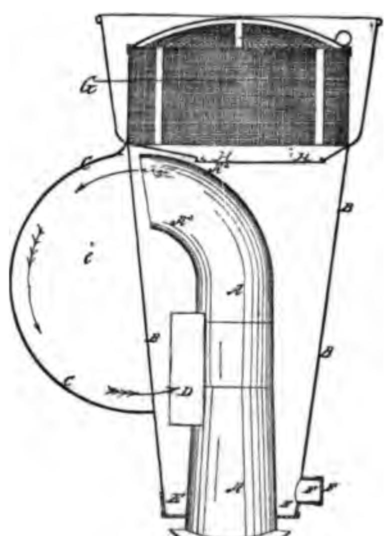
EXHIBIT–15

Fig 1



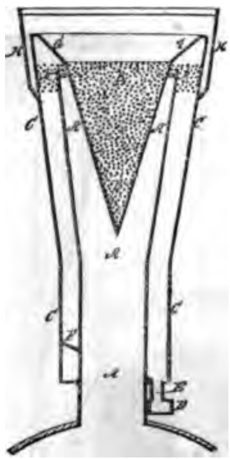
R. French—Patented June 16, 1841.

EXHIBIT–16.



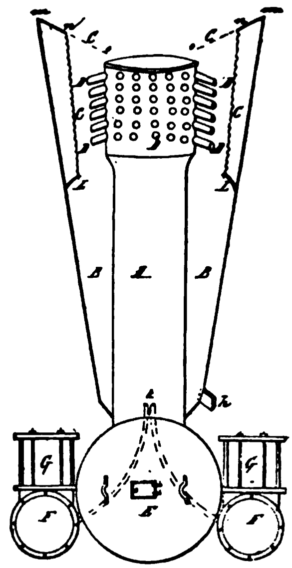
J. V. L. Hoagland—Patented March 18, 1842.

EXHIBIT—17.



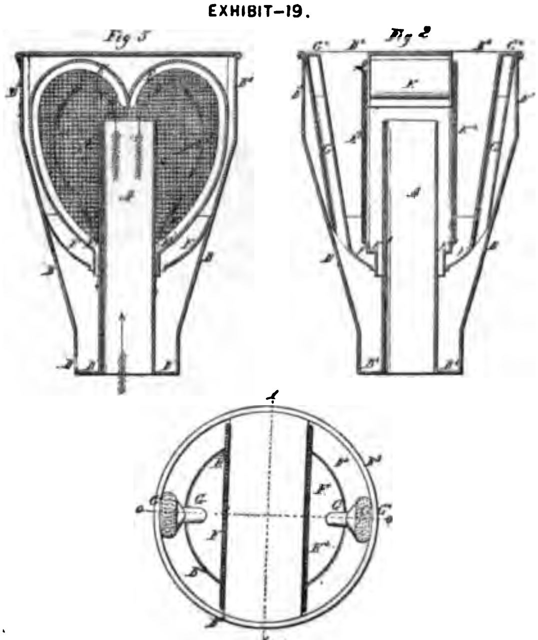
A. Keagy—Patented April 29, 1842.

EXHIBIT—18.



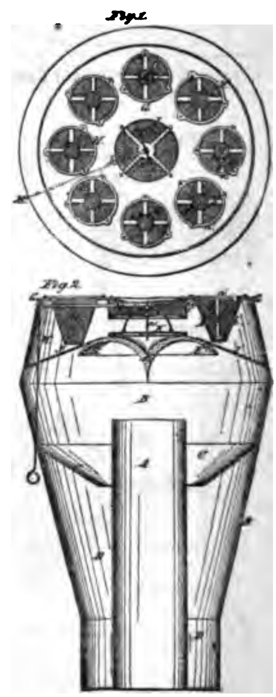
J. Eckler—Patented Oct. 7, 1842.

EXHIBIT—19.



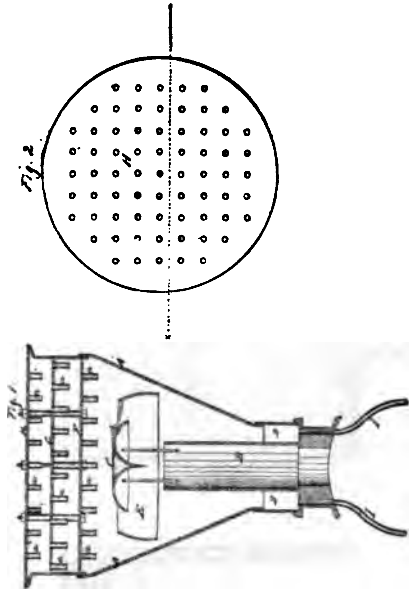
S. Sweet, Jr.—Patented August 26, 1846.

EXHIBIT—20.



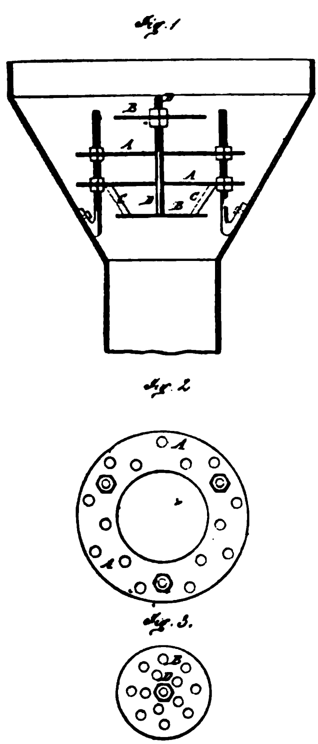
S. Sweet—Pat. Oct. 25, 1853.

EXHIBIT—21.



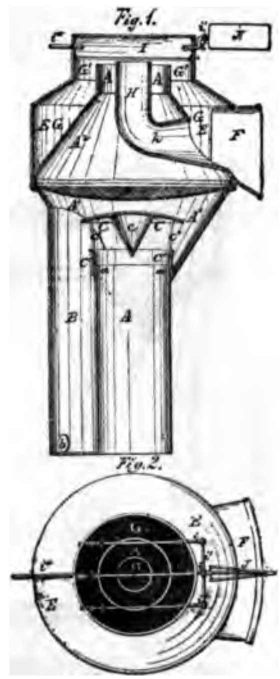
J. W. Bowker—Patented October 19, 1869.

EXHIBIT—23.



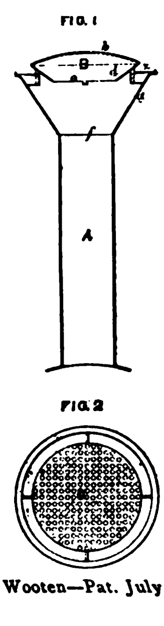
J. Hughes—Patented Nov. 4, 1873.

EXHIBIT—22.



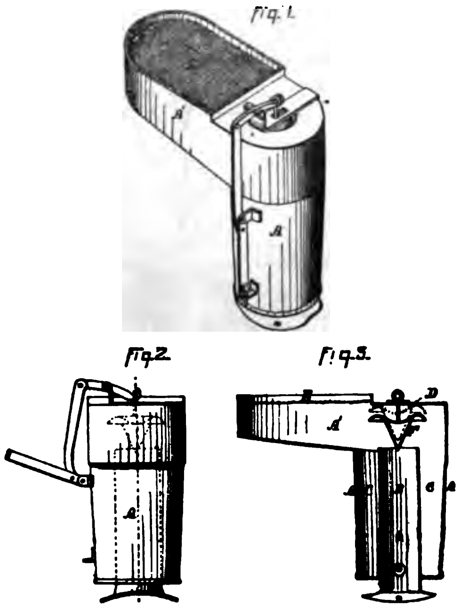
A. W. Crane—Pat. June 10, 1873.

EXHIBIT—24.



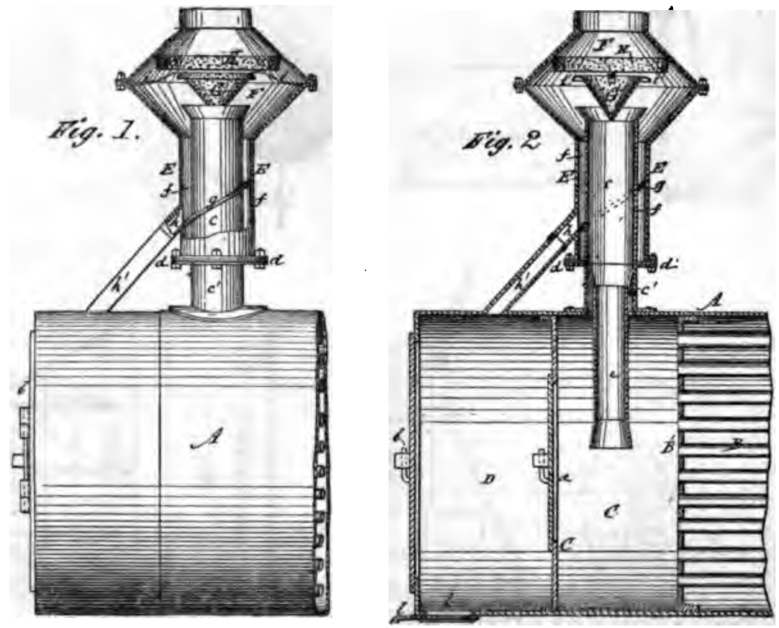
J. E. Wooten—Pat. July 14, 1874.

EXHIBIT-25.



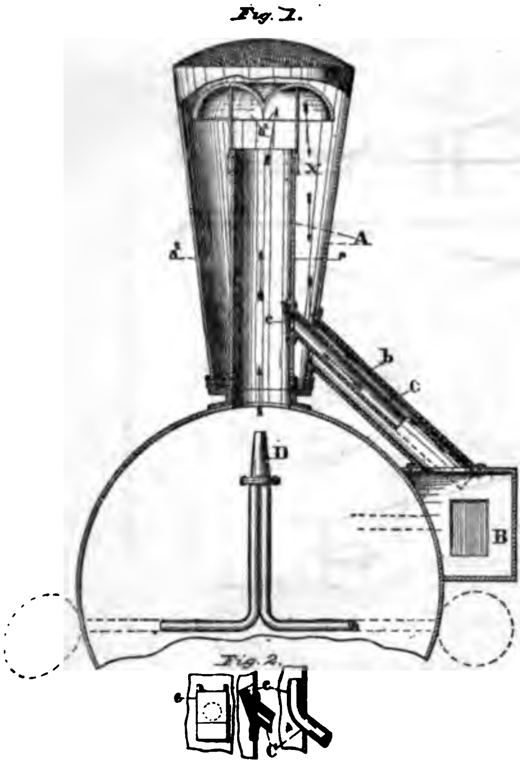
H. V. Faries—Patented May 11, 1875.

EXHIBIT-26.



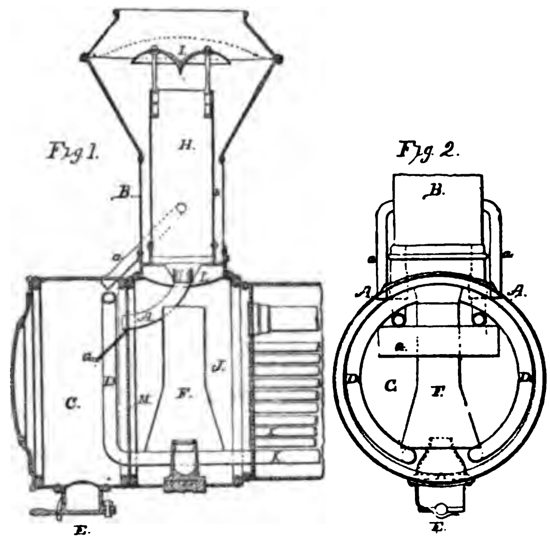
W. S. Cosgrove—Patented August 26, 1879.

EXHIBIT-27.



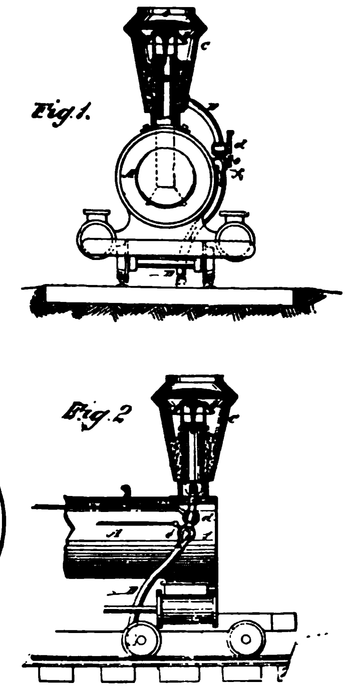
Dunn & Havner—Patented May 11, 1880.

EXHIBIT-28.



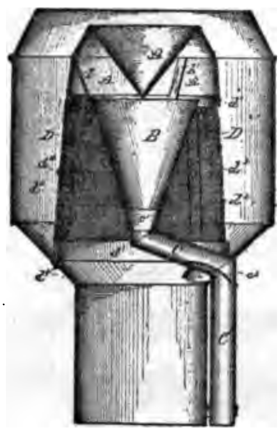
J. K. Taylor—Patented September 20, 1881.

EXHIBIT-29.



W. K. Schermerhorn—Pat. March 28, 1882.

EXHIBIT-30.



A. Blake—Patented July 25, 1882.

EXHIBIT-31.

Fig. 1.

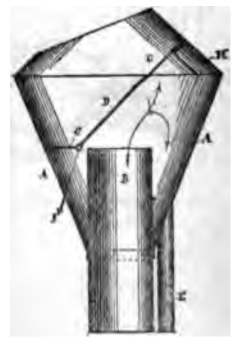
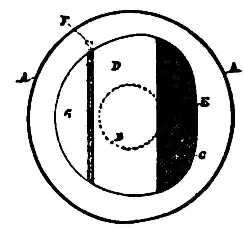
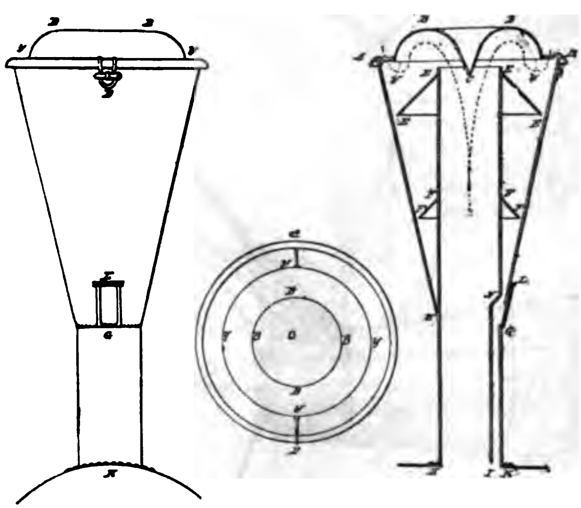


Fig. 2.



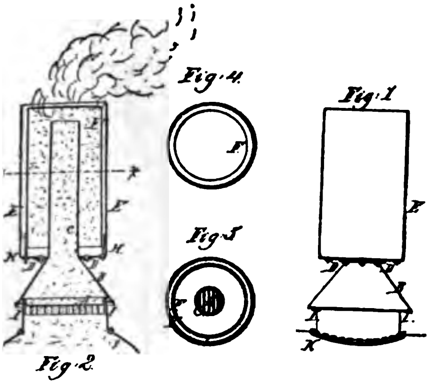
L. C. Sparks—Patented Oct. 3, 1882.

EXHIBIT-32.



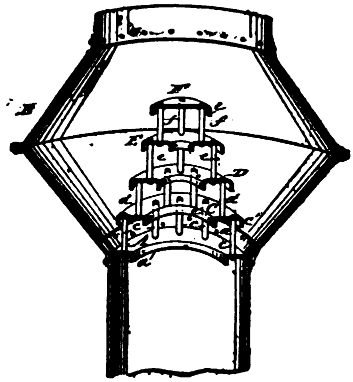
Smith & Van Loon—Patented June 30, 1838.

EXHIBIT-33.



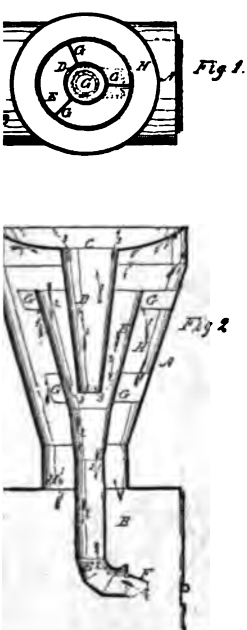
N. Turbott—Patented December 30, 1839.

EXHIBIT-[illegible]



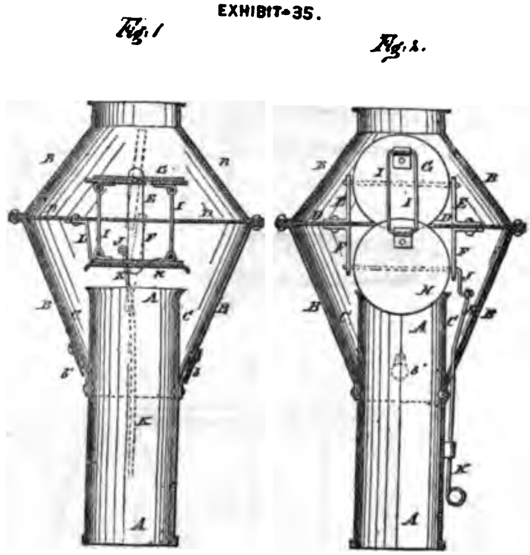
G. S. Cook—Patented February 7, 1882.

EXHIBIT-34.



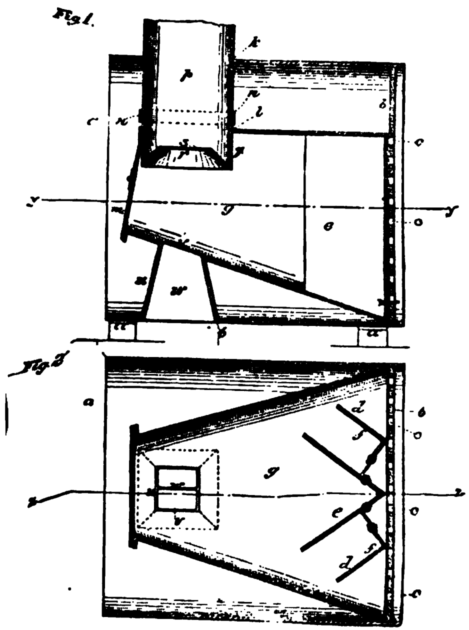
Abos—Pat. June 13, 1854.

EXHIBIT-35.



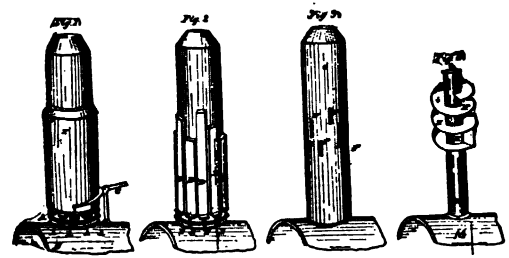
E. N. Berry—Patented September 30, 1879.

EXHIBIT-37.



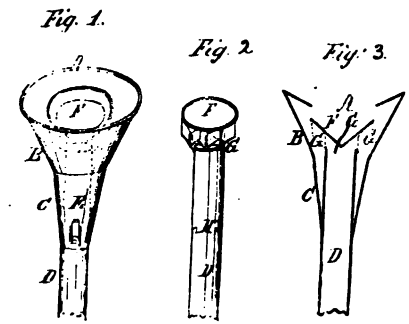
J. D. Ackley—Patented March 28, 1882.

EXHIBIT-38.



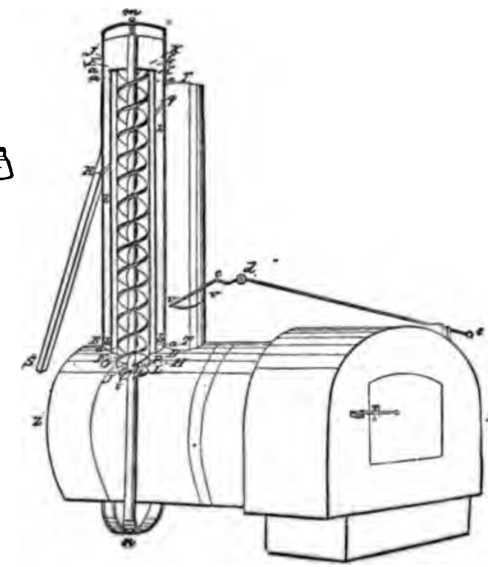
J. Stimson—Patented August 17, 1837.

EXHIBIT-39.



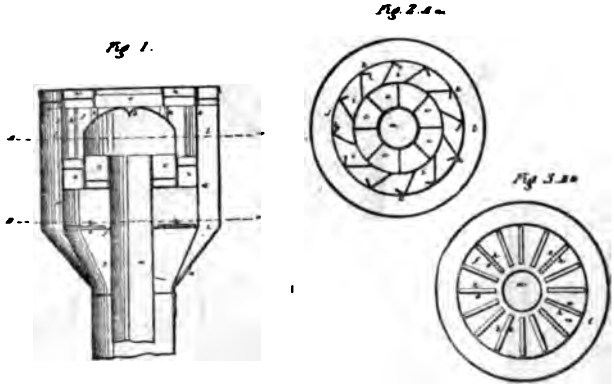
W. T. James—Patented April 13, 1838.

EXHIBIT-40.



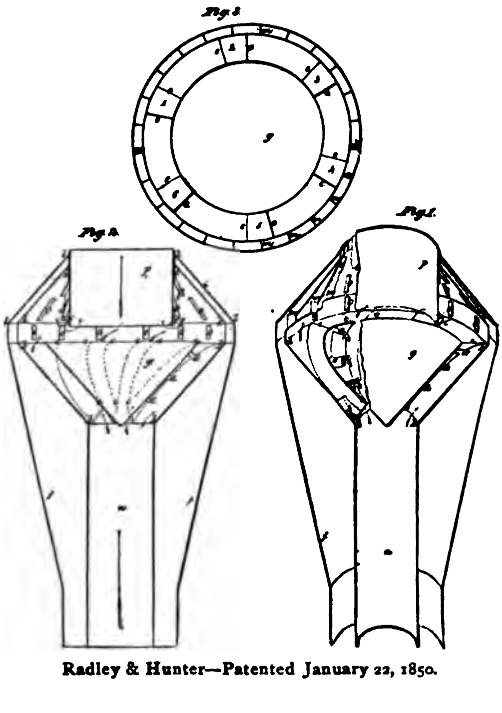
S. Gibson—Patented May 22, 1847.

EXHIBIT-41.



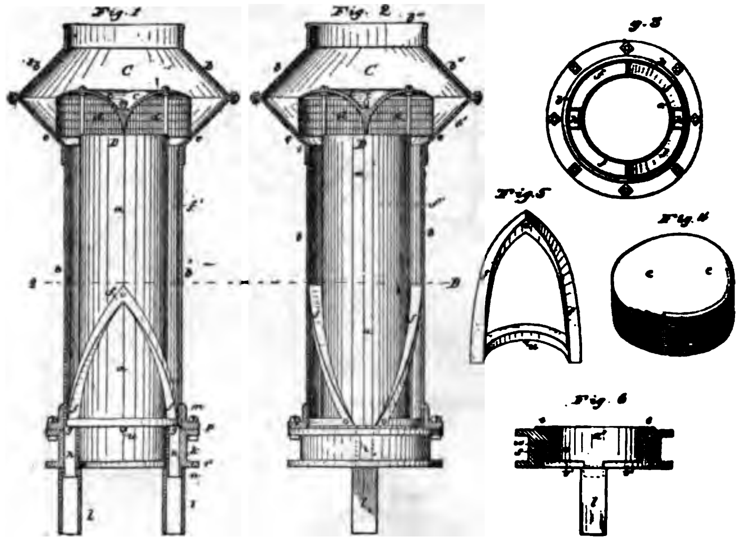
J. A. Cutting—Patented June 26, 1849.

EXHIBIT-42.



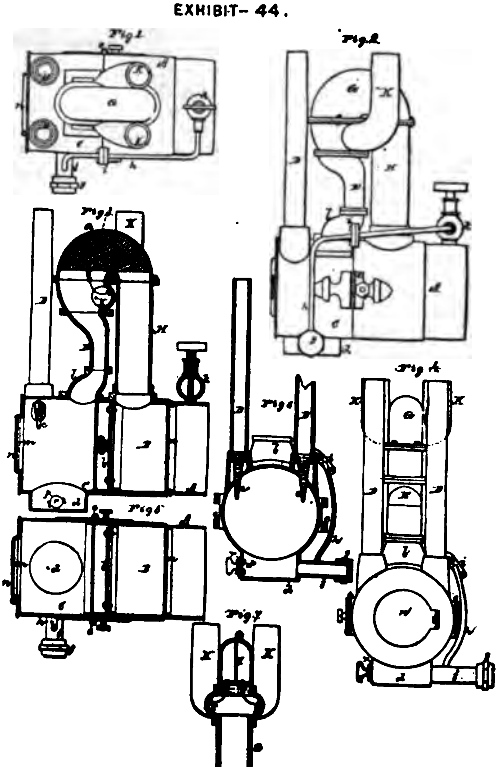
Radley & Hunter—Patented January 22, 1850.

EXHIBIT- 43.

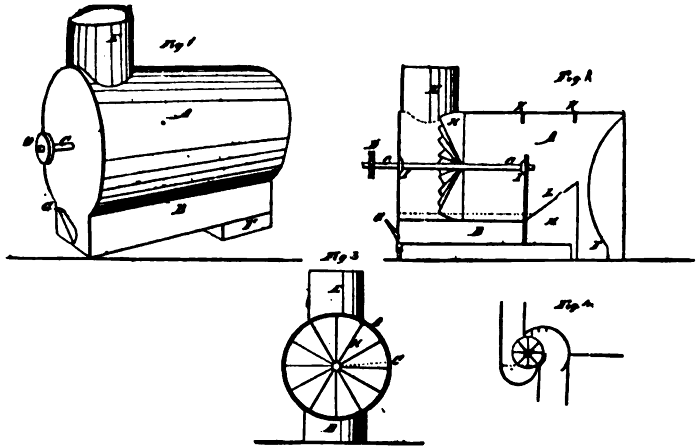


Ball & Brooks—Patented July 26, 1881.

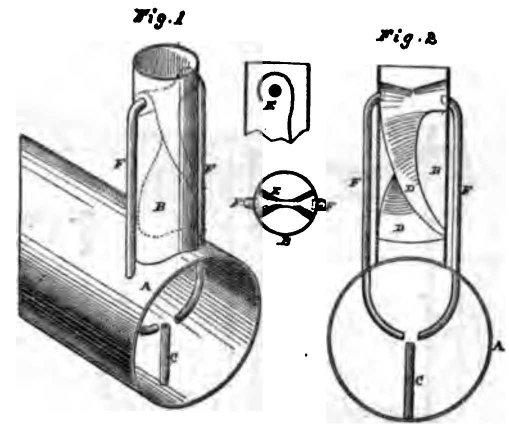
EXHIBIT- 44.



F. N. Stevens—Patented July 26, 1876.

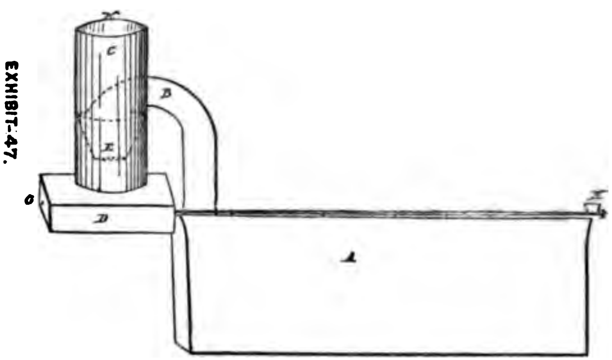


J. Finlay—Patented December 28, 1838.



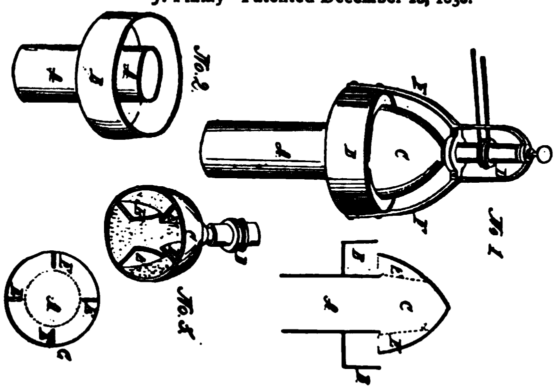
J. H. Bartlett—Patented December 10, 1878.

EXHIBIT-46



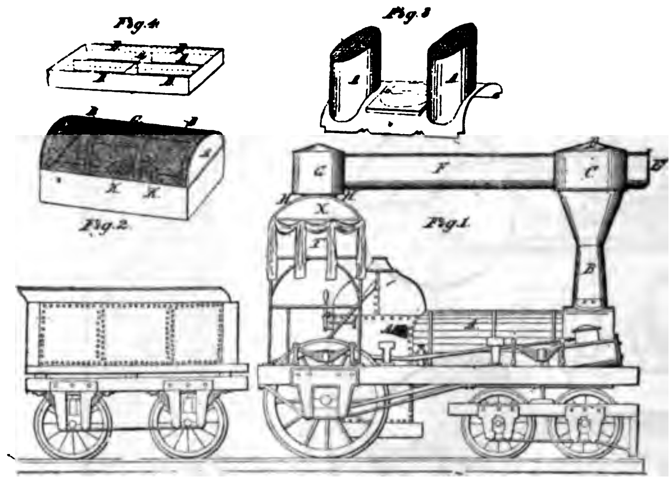
T. Newhall, Jr.—Patented January 27, 1838.

EXHIBIT-47.



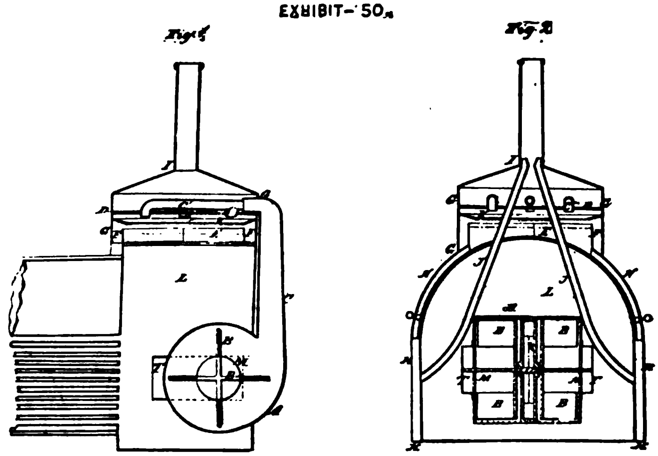
S. Leonard—Patented December 15, 1838.

EXHIBIT—49.



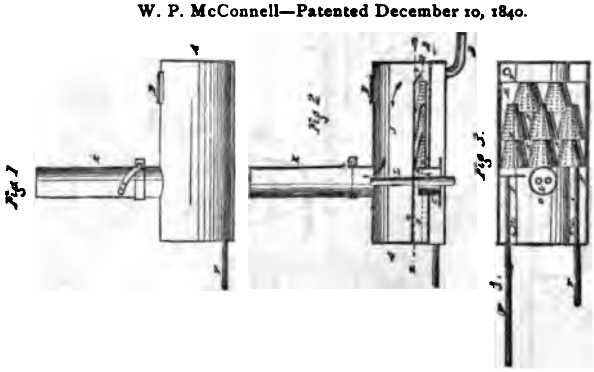
D. Ritter—Patented November 26, 1840.

EXHIBIT—50.



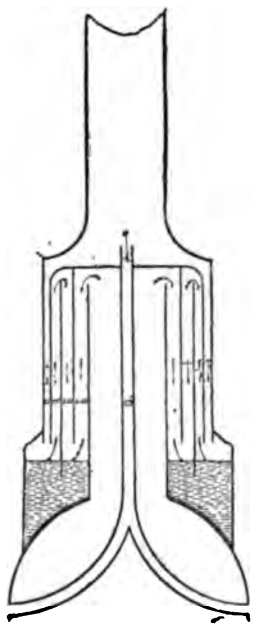
W. P. McConnell—Patented December 10, 1840.

EXHIBIT—51.



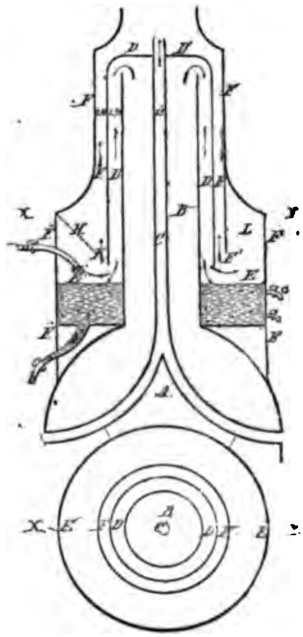
Z. Wilber—Patented January 10, 1843.

EXHIBIT-52.



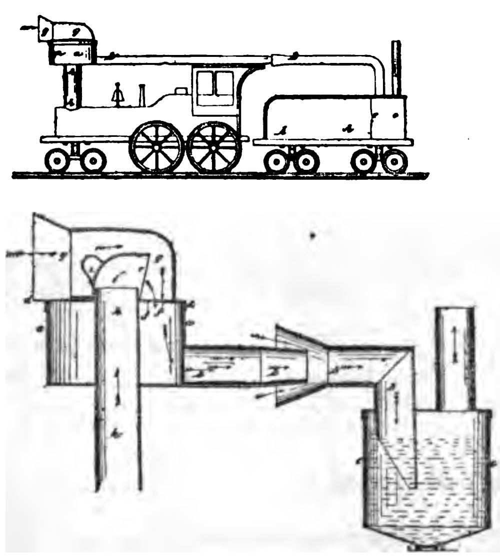
J. A. Roebling—Pat. Feb. 16, 1843.

EXHIBIT-52.



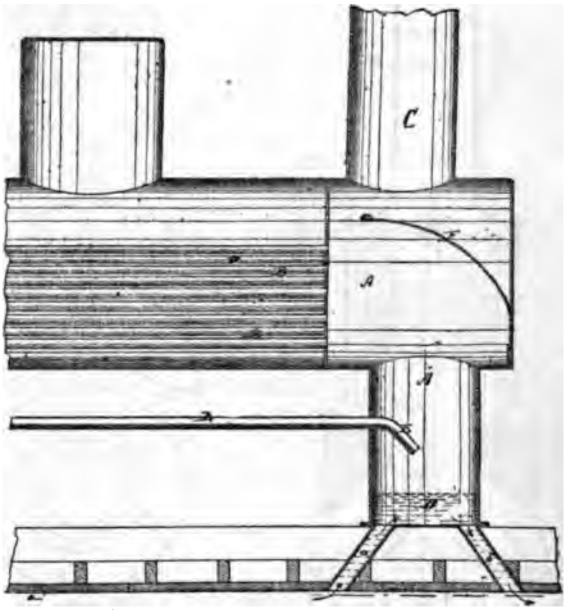
The same.

EXHIBIT-53.



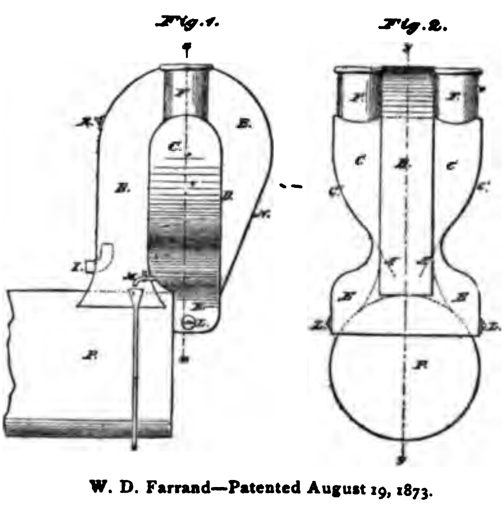
C. B. Keys—Patented June 19, 1866.

EXHIBIT-54.



J. Gates—Patented October 31, 1871.

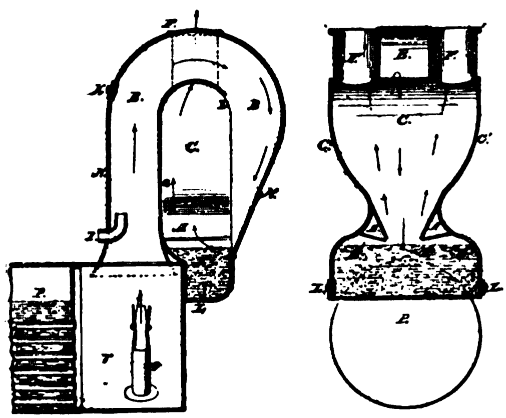
EXHIBIT-55.



W. D. Farrand—Patented August 19, 1873.

EXHIBIT—55.

Fig. 3. Fig. 4.



W. D. Farrand—Patented August 19, 1873.

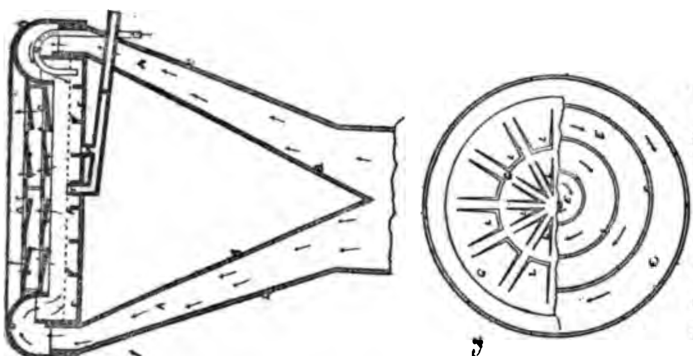
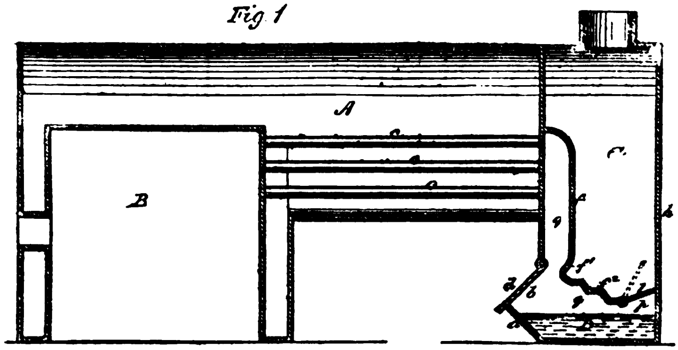


FIG 1 FIG 2

A. W. Farrand—Patented Nov. 28, 1876.

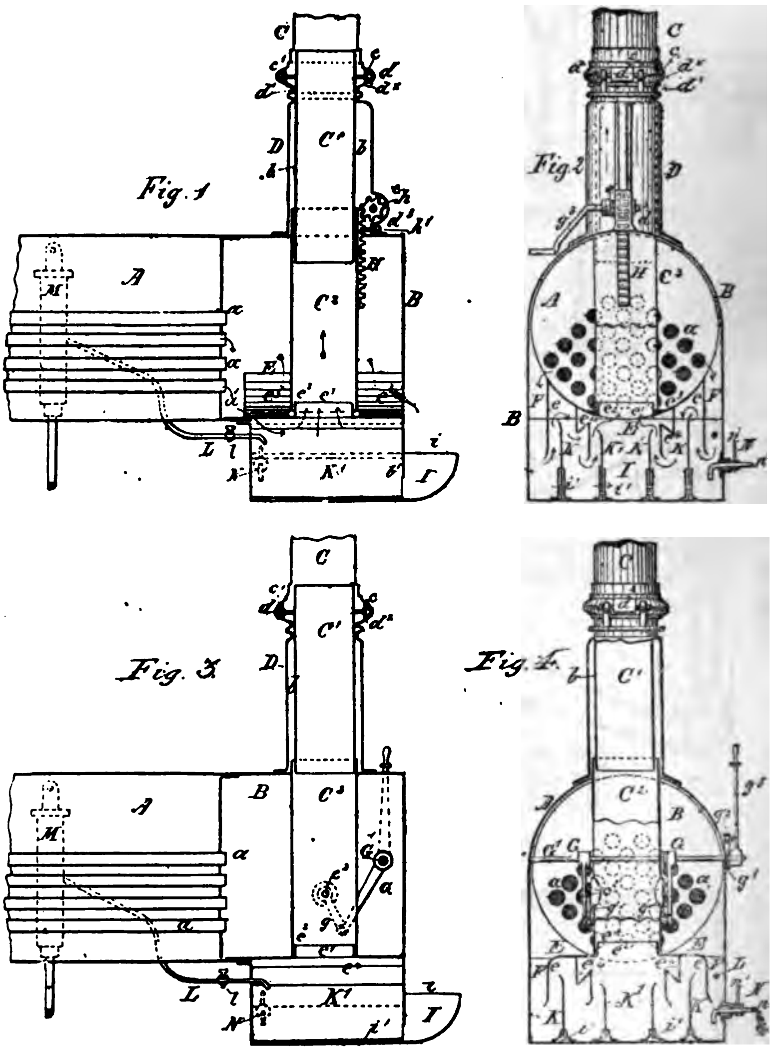
EXHIBIT—57.

Fig 1



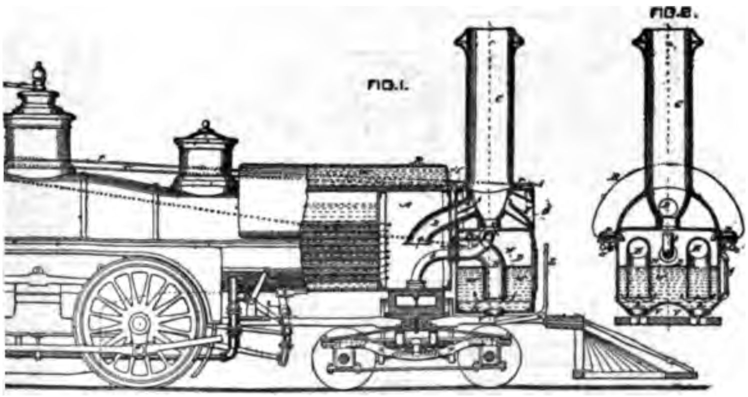
T. W. Goodwin—Patented December 25, 1877.

EXHIBIT 58.



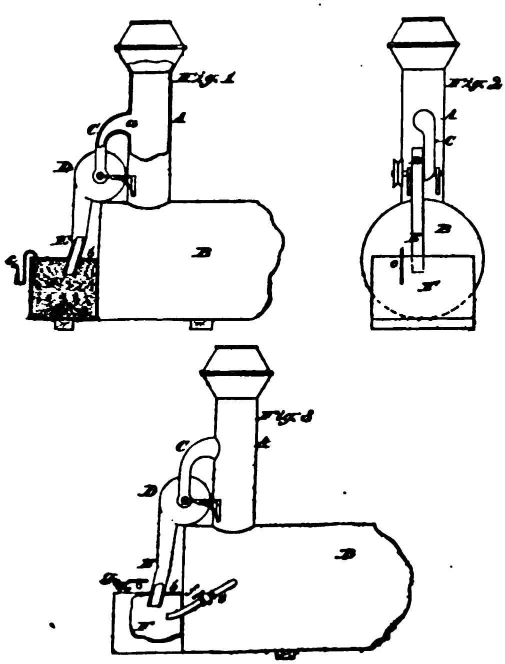
A. Delaney—Patented February 3, 1880.

EXHIBIT-59.



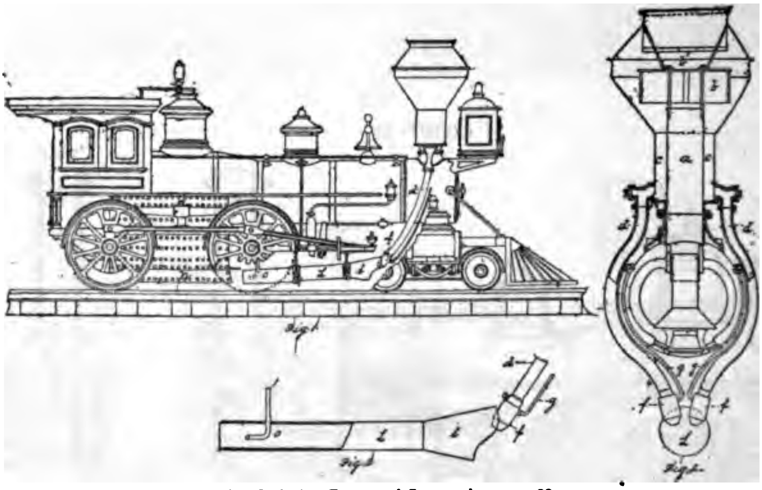
D. Groesbeck—Patented December 21, 1880.

EXHIBIT-60.



E. W. Wright—Patented December 27, 1881.

EXHIBIT-61.



G. B. Nichols—Patented September 12, 1882.

EXHIBIT—62.

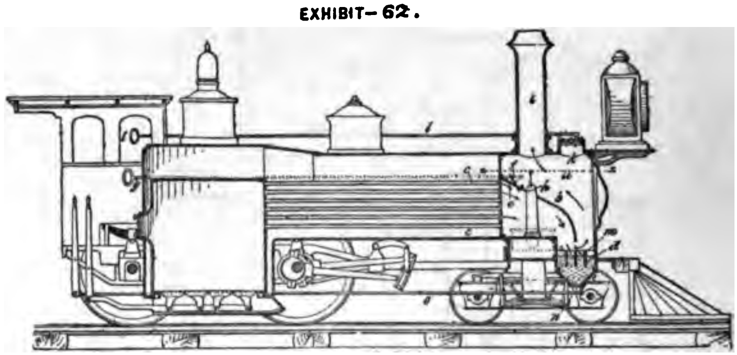


Fig. 1.

D. Groesbeck—Patented January 9, 1883.

EXHIBIT-62.

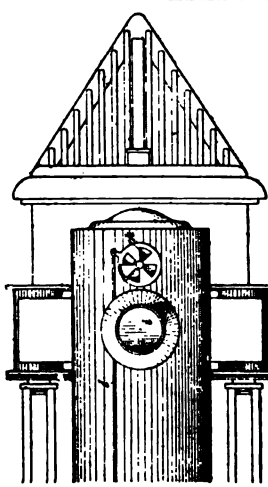


Fig. 2.

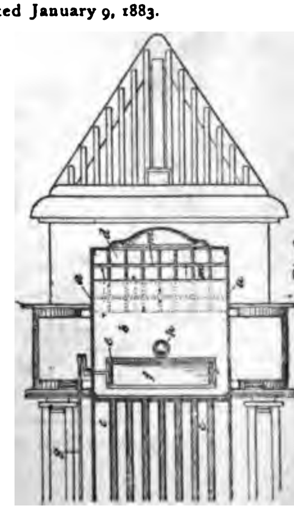
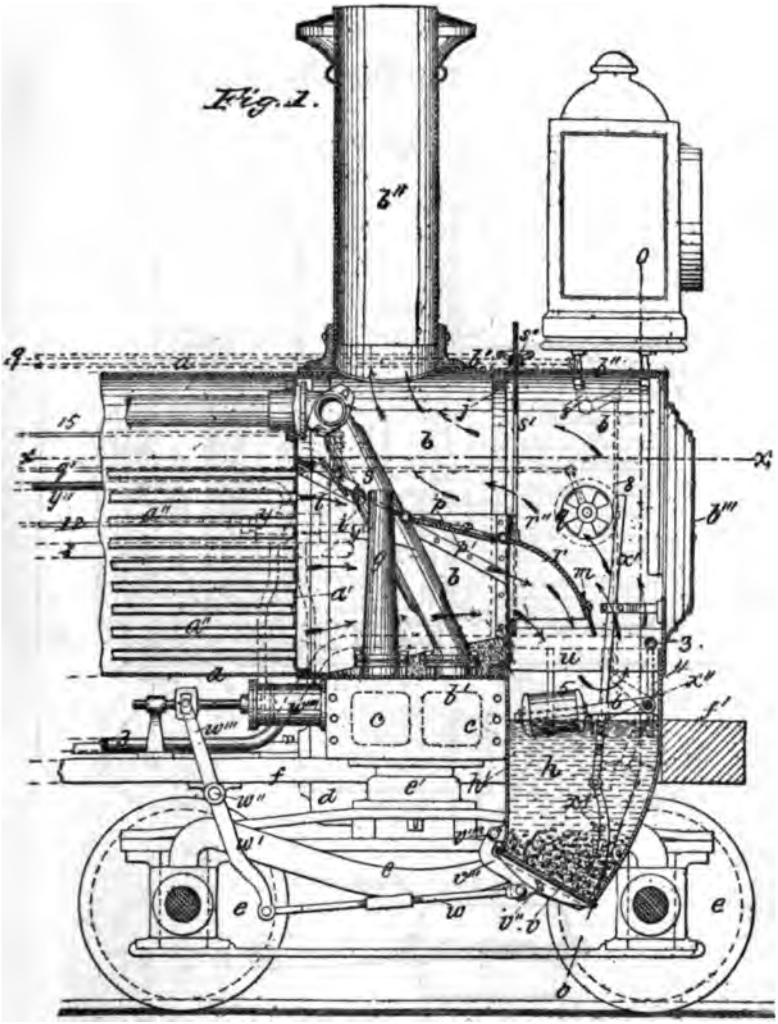


Fig. 3.

D. Groesbeck—Patented January 9, 1883.

EXHIBIT-63.



Groesbeck, Sterling & Ball—Patented January 9, 1883.

EXHIBIT–63.

Fig. 2.

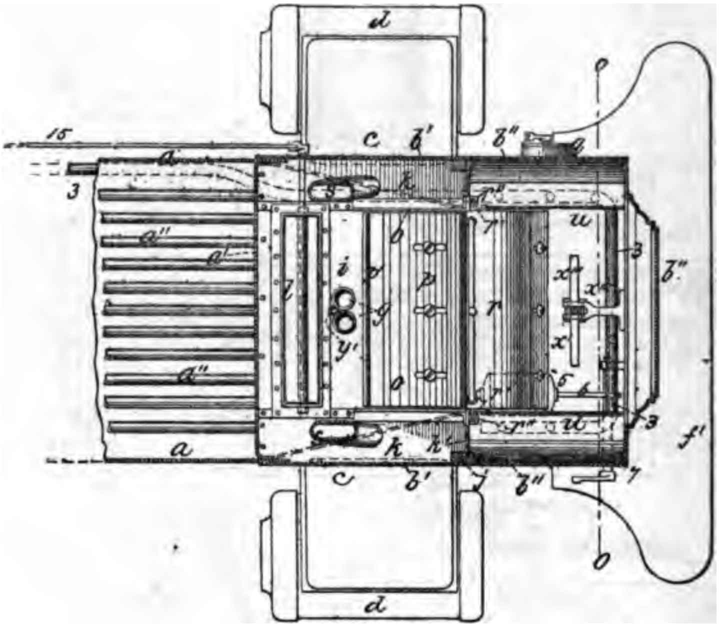


Fig. 7.

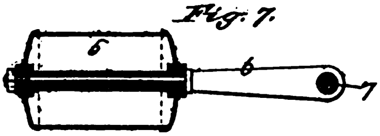


EXHIBIT-63.

Fig. 8.

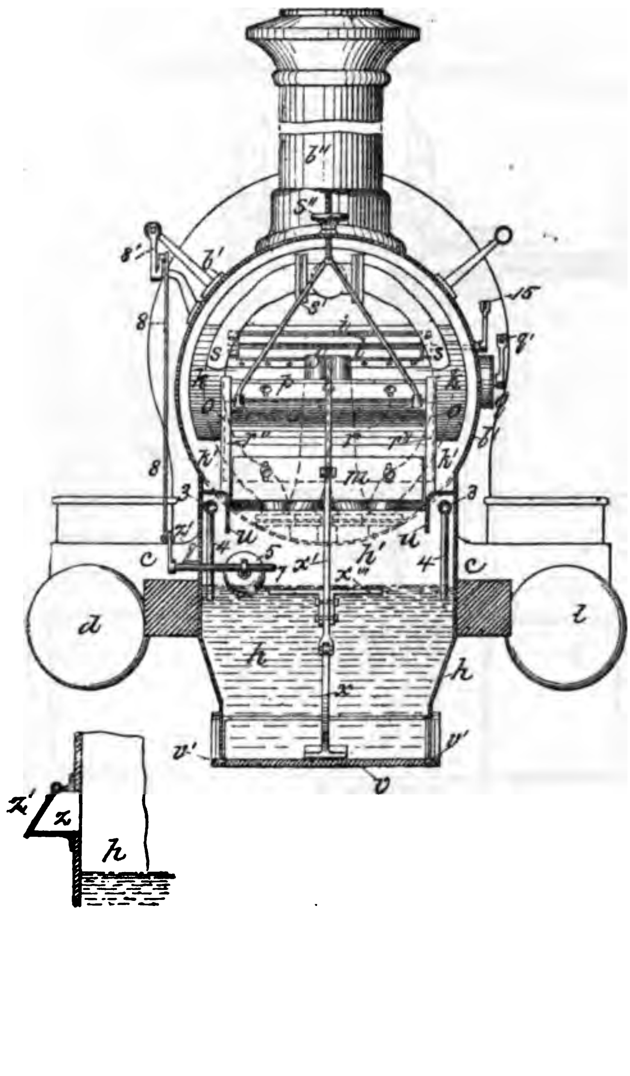


EXHIBIT-63.

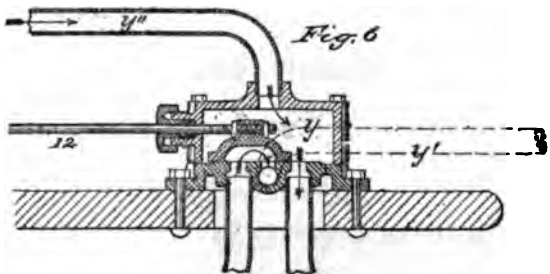


Fig. 6

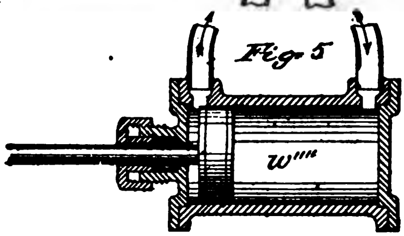


Fig. 5

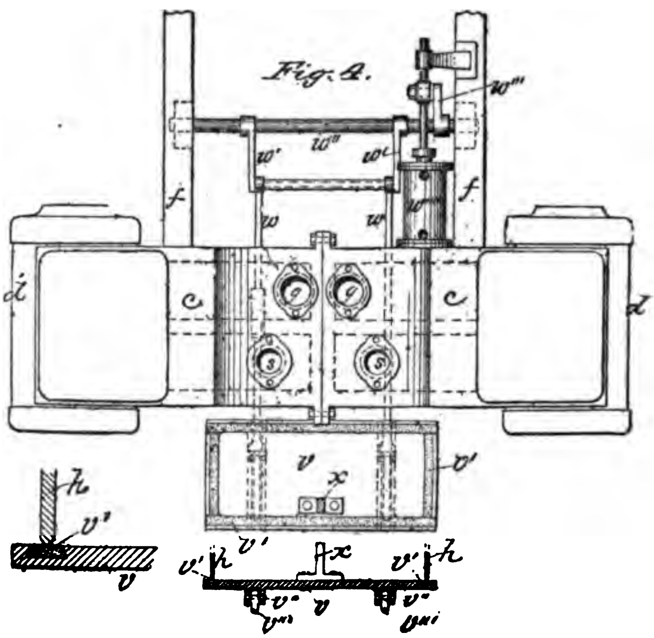
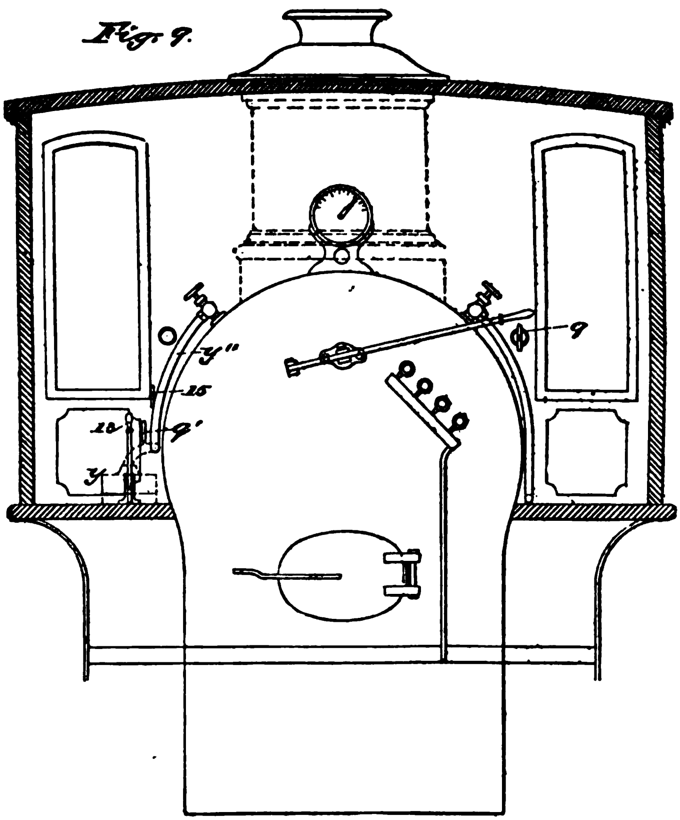


Fig. 4.

EXHIBIT-63

Fig. 9.



EXHIBIT–63.

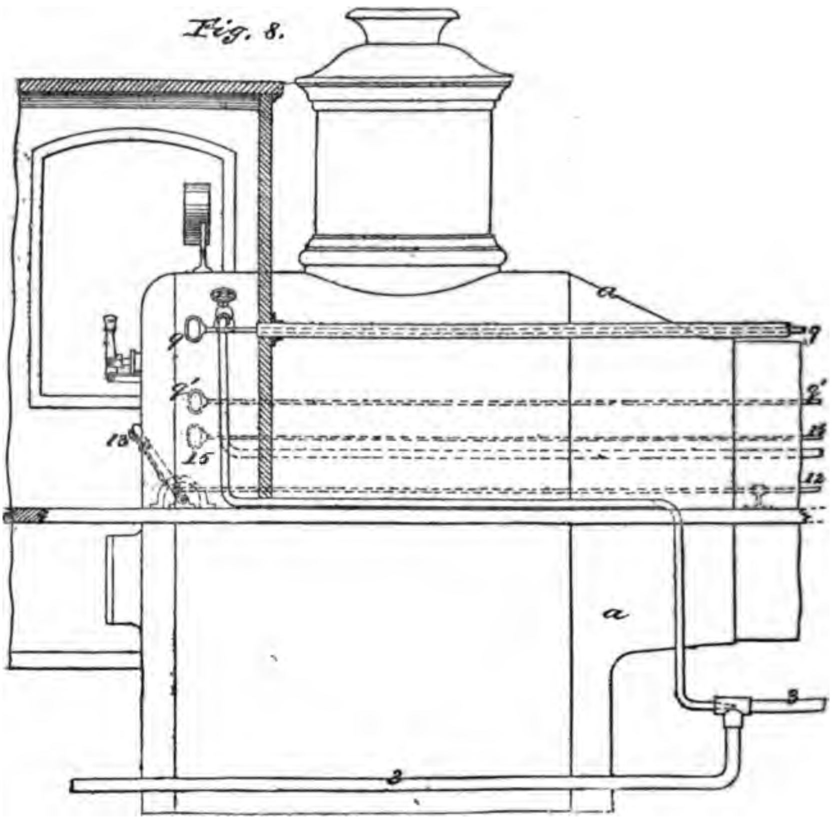
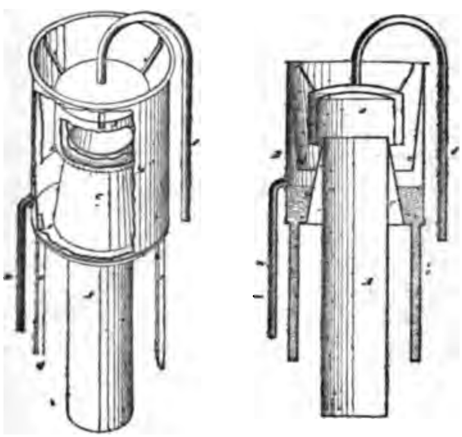


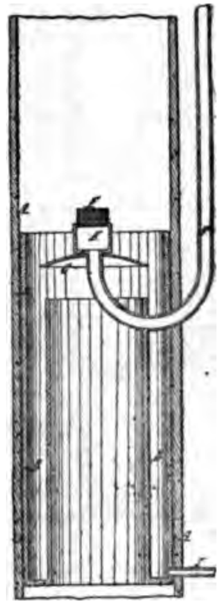
EXHIBIT-64.

Fig. 1. Fig. 2.



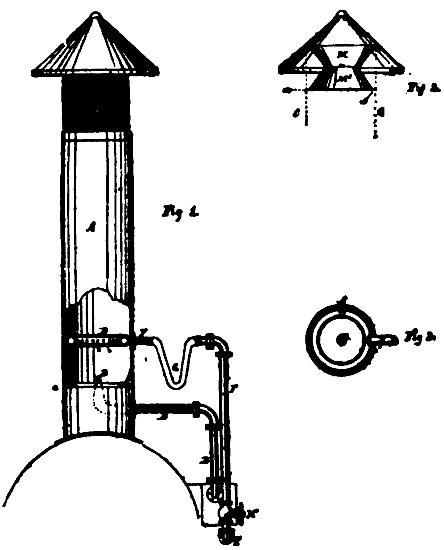
Cutting & Butterfield—Patented June 19, 1847.

EXHIBIT-65.



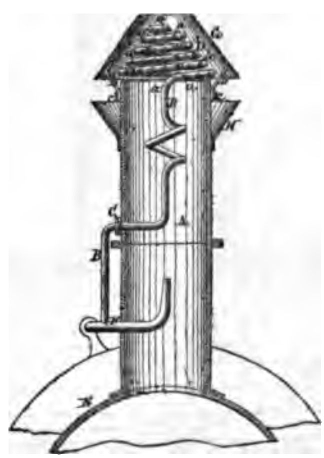
H. Chase—Patented Sept. 2, 1856.

EXHIBIT-66.



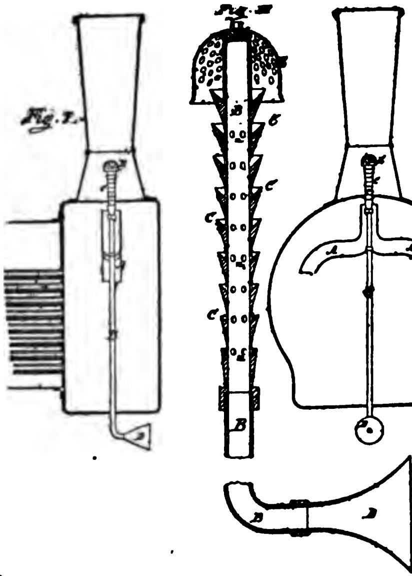
M. Rumley—Patented September 29, 1874.

EXHIBIT-67.



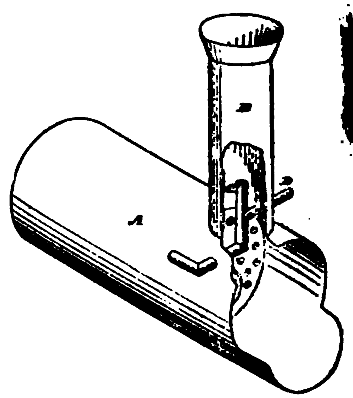
J. G. May—Patented Feb. 22, 1876

EXHIBIT-68



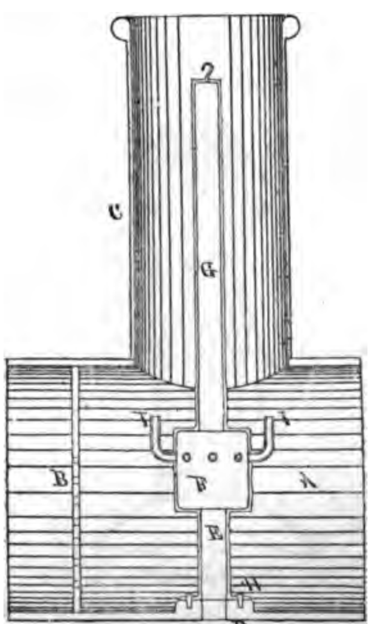
C. H. Prussman—Patented February 6, 1877.

EXHIBIT 69.



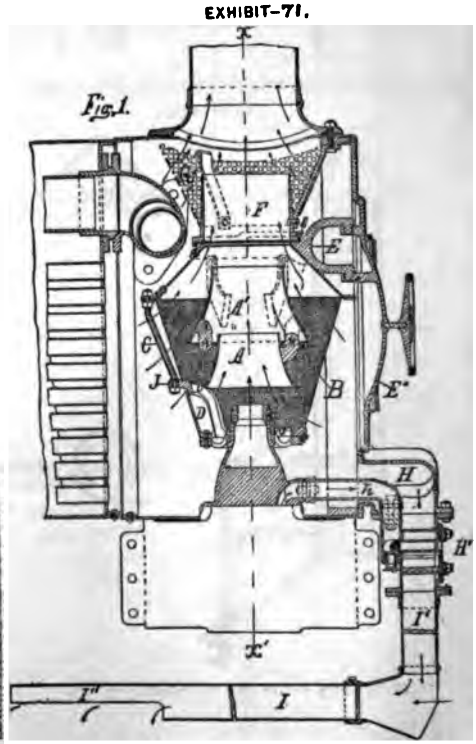
Donaldson & Miller—Pat. Nov. 24, 1876.

EXHIBIT-70.



T. Shaw—Patented August 28, 1877.

EXHIBIT-71.



D. G. Hunter—Patented October 28, 1879.

EXHIBIT-71.

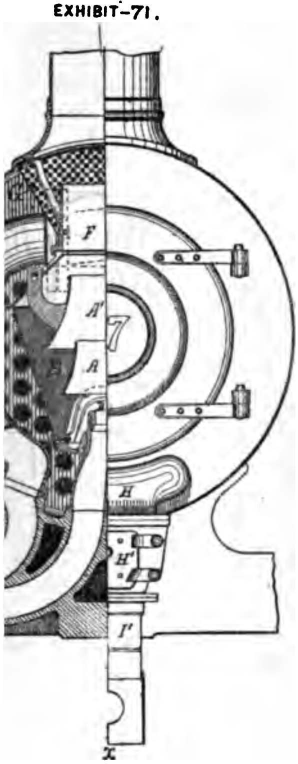
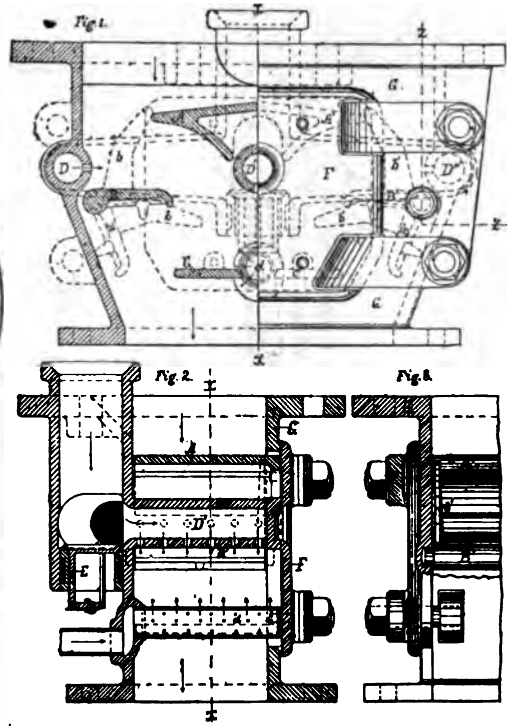


EXHIBIT-72.



G. D. Hunter—Patented October 28, 1879.

EXHIBIT-73.

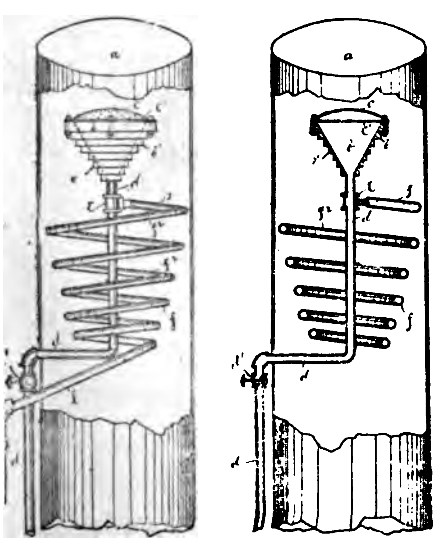
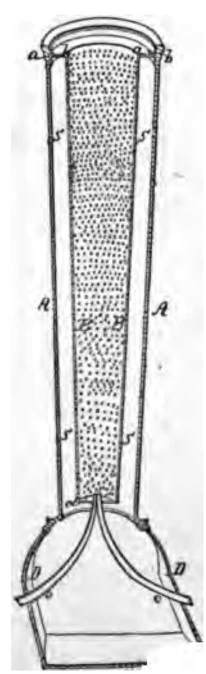


Fig 1 Fig 2

I. Doyell—Patented February 28, 1882.

EXHIBIT-74.



W. Knight-

EXHIBIT—75.

Fig. 1

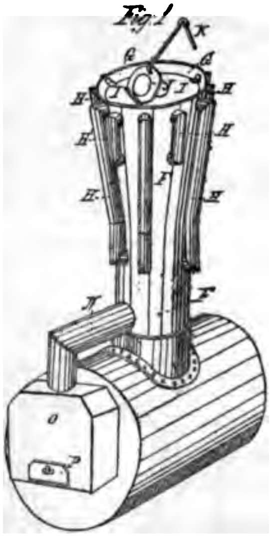


Fig. 2

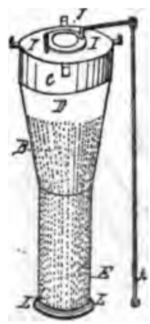
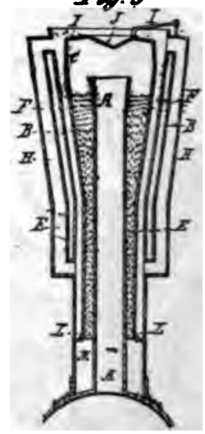


Fig. 3



L. Phleger—Patented Spetember 10, 1840.

EXHIBIT—76.

Fig. 1

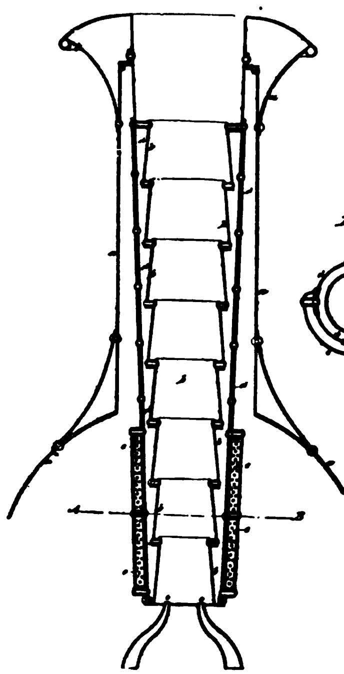
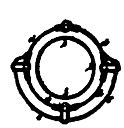
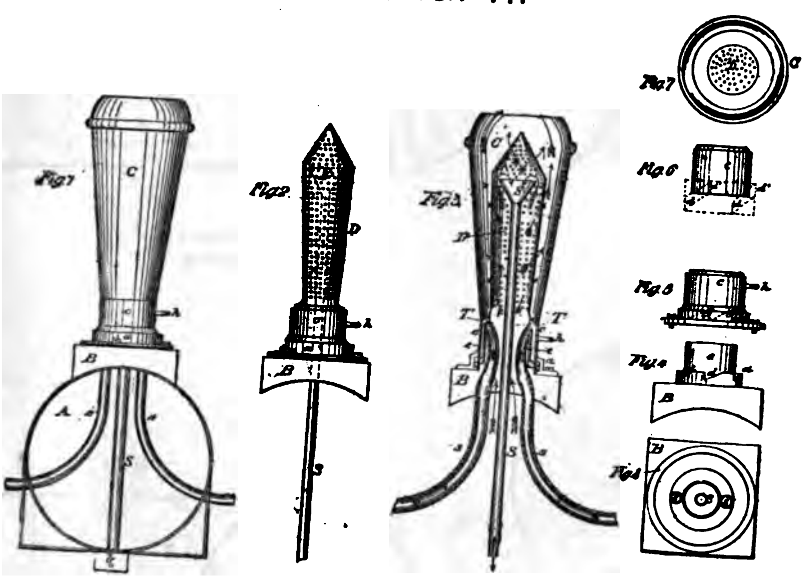


Fig. 2



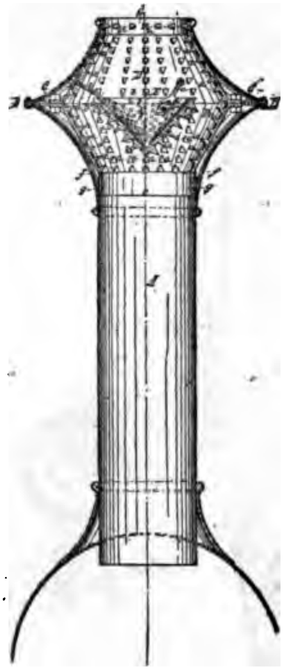
J. Marx—Patented October 5, 1858.

EXHIBIT=77



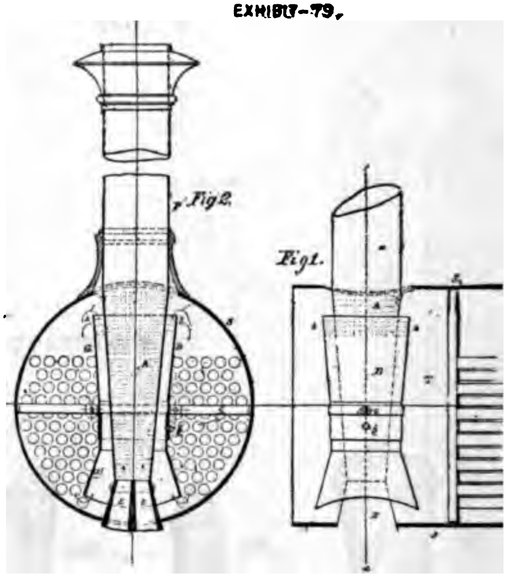
Peaslee & Lilly—Patented December 6, 1869.

EXHIBIT–78.



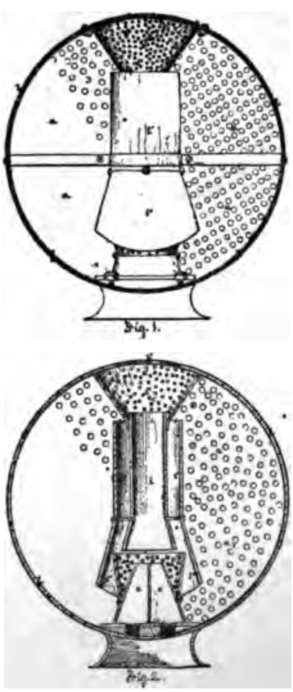
C. P. Noble—Pat. Aug. 11, 1863.

EXHIBIT–79.



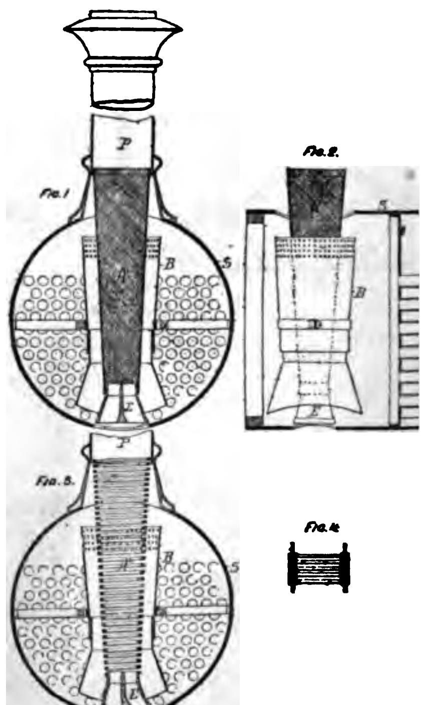
J. Smith—Patented August 16, 1870.

EXHIBIT–80.



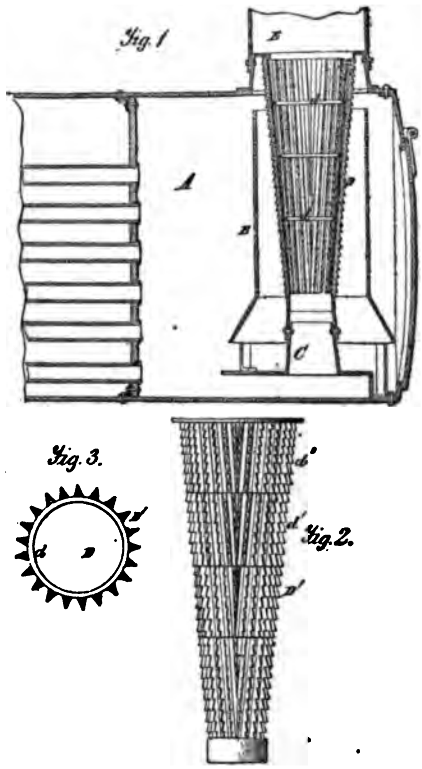
Weidman, Major & Sample—Patented Dec. 20, 1870.

EXHIBIT–81.



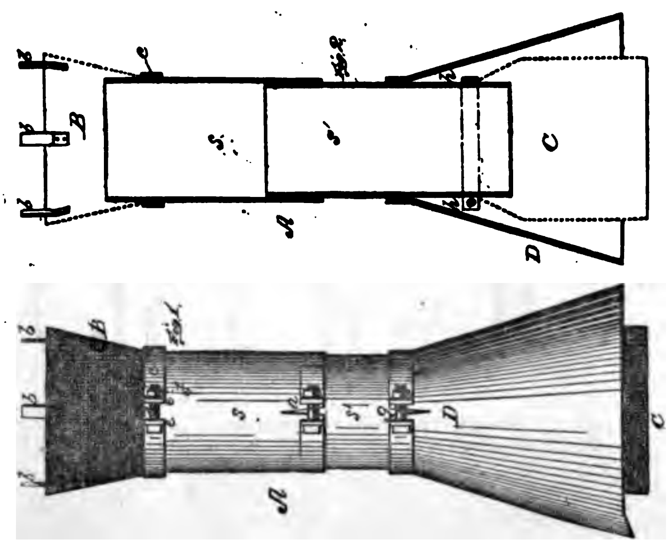
J. Smith—Patented March 7, 1872.

EXHIBIT-82.



W. F. Grassler—Patented September 29, 1874.

EXHIBIT-83.



J. D. Ackley—Patented January 14, 1879.

EXHIBIT-83.

FIG. I.

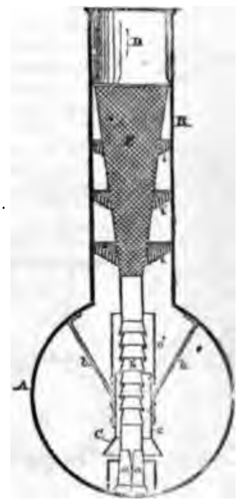
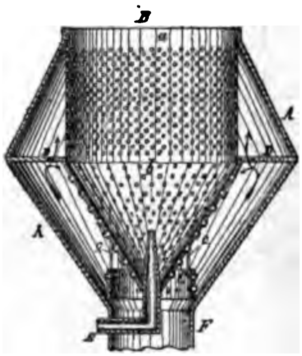


EXHIBIT-84.



J. Kirkland—Patented Jan. 6, 1880.

Craig & Wyman—Pat. March 9, 1880.

EXHIBIT-85.

FIG. IV.

FIG. III

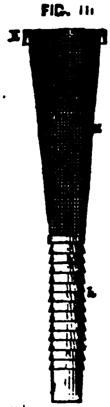


FIG. II.

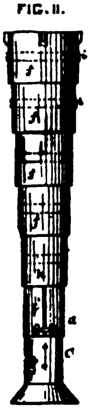
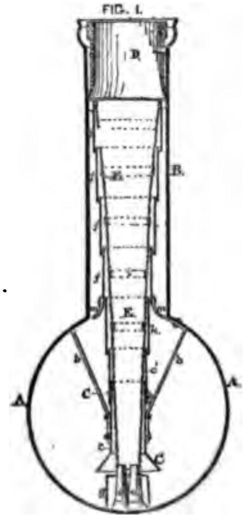
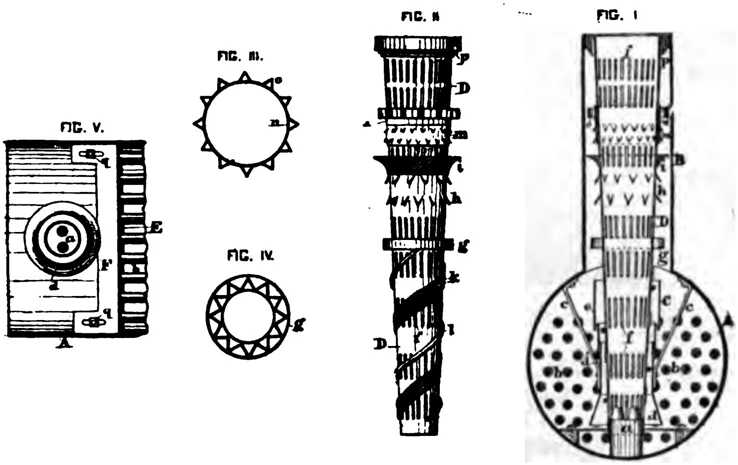


FIG. I.



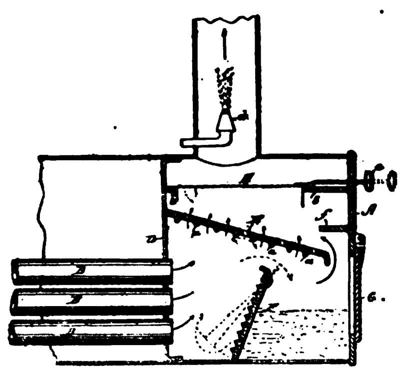
Craig & Wyman—Patented March 9, 1880.

EXHIBIT-86.



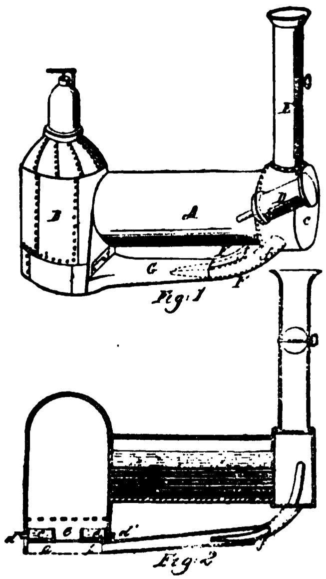
Craig & Wyman—Patented October 19, 1880.

EXHIBIT-87



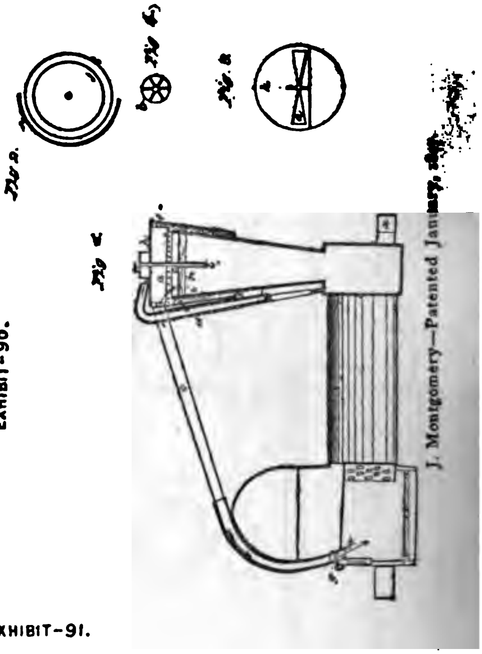
Moore & Frick—Patented January 10, 1882.

EXHIBIT-89.



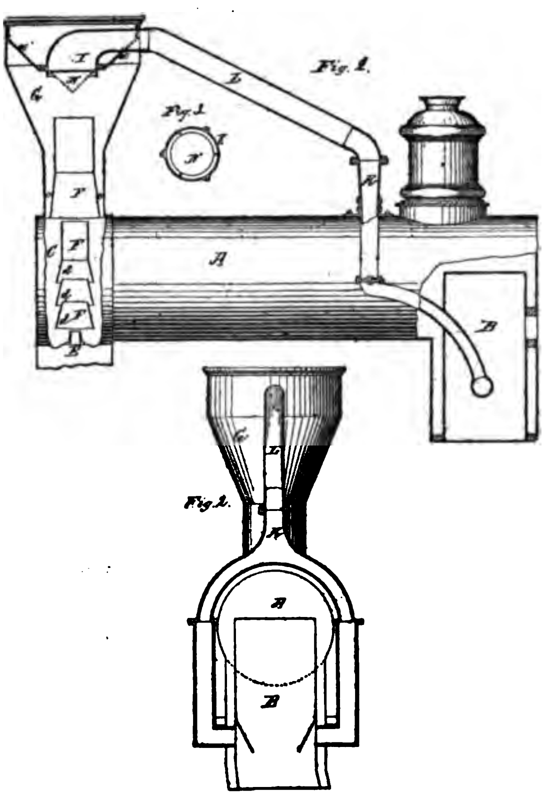
Longmayer & Brooke—Pat. July 10, 1840.

EXHIBIT-90.



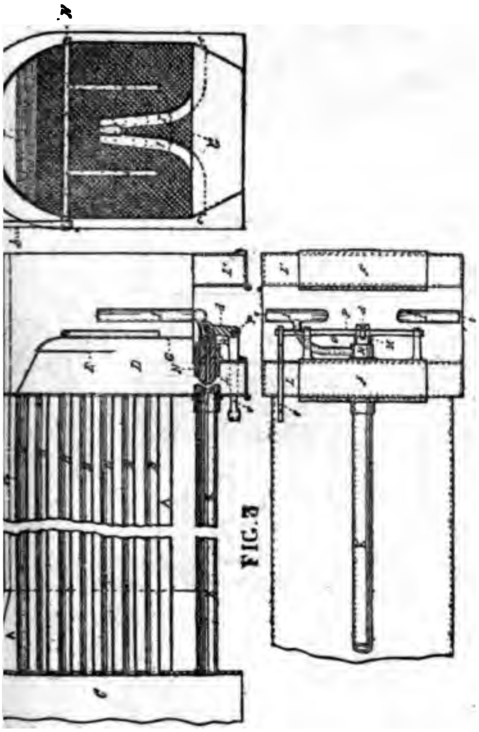
J. Montgomery—Patented January, 18[illegible]

EXHIBIT-91.



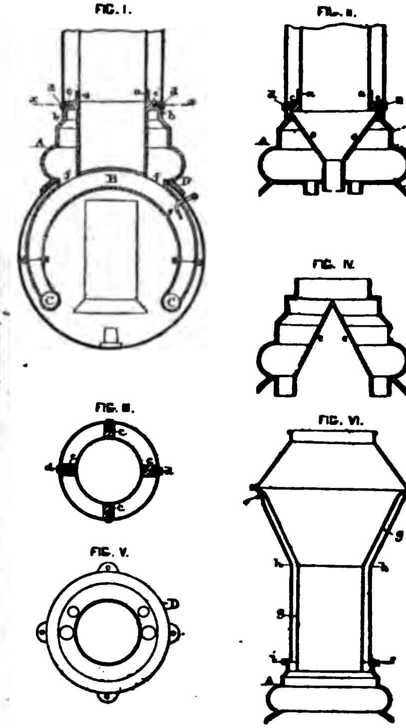
G. H. Griggs—Patented September 10, 1872.

EXHIBIT-93.



R. Hill—Patented June 23, 1874.

EXHIBIT-94.



A. Berney—Patented March 1, 1881.

EXHIBIT-95.

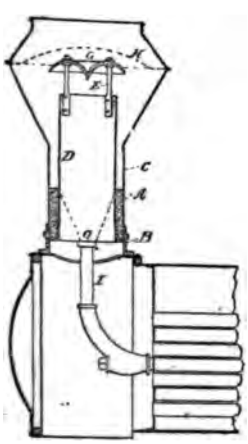


Fig. 1.

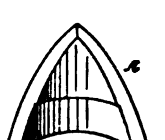
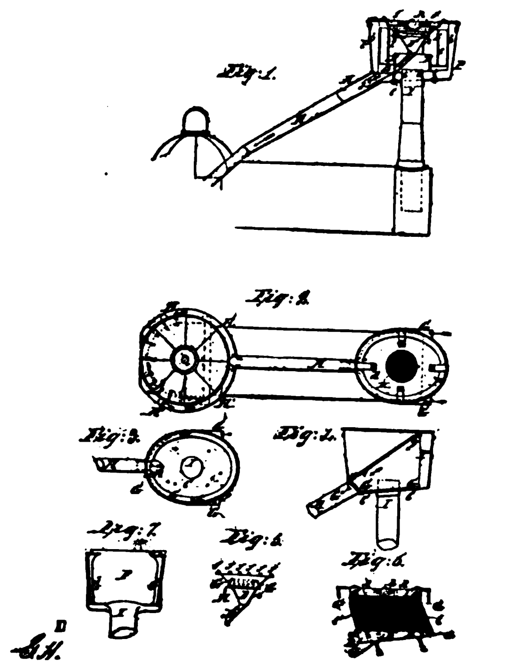


Fig. 2.

-rney—Patented March 22, 1881.

EXHIBIT-96.



D. Matthew—Patented February 20, 1856.

EXHIBIT-96.

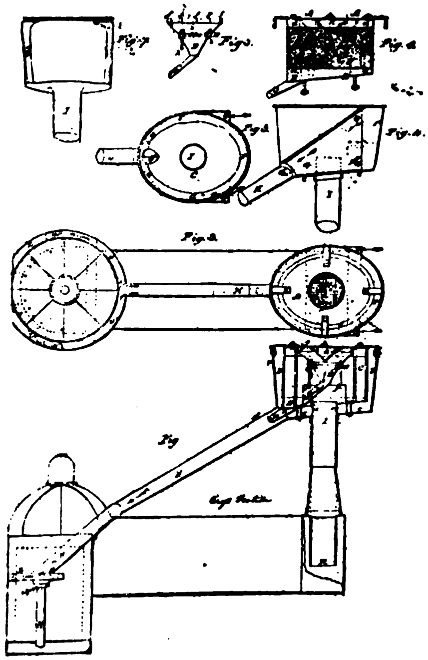
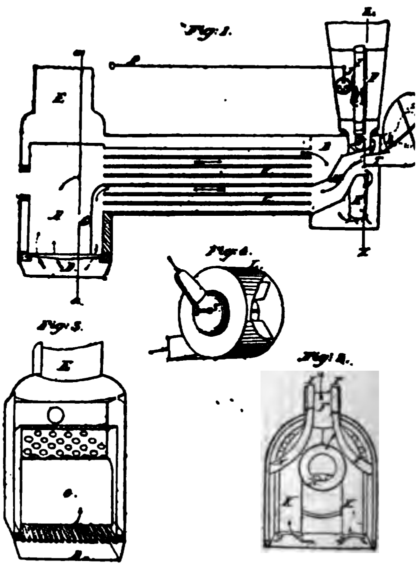
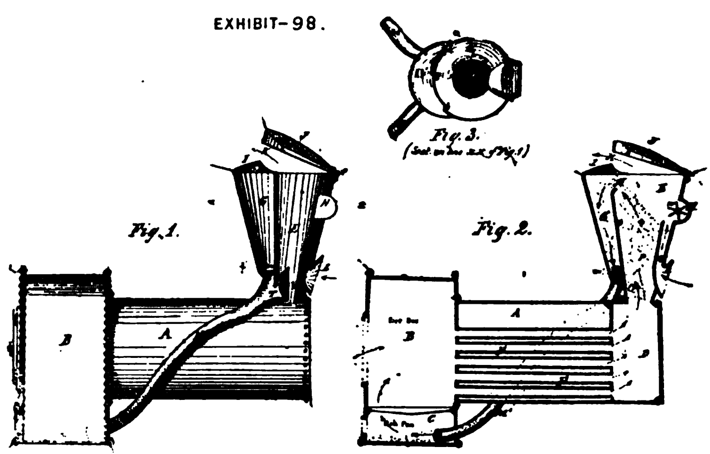


EXHIBIT-97.



B. F. Blood—Patented December 29, 1857.

EXHIBIT-98.



L. Bell—Patented May 23, 1871.

EXHIBIT—99.

Fig. 2

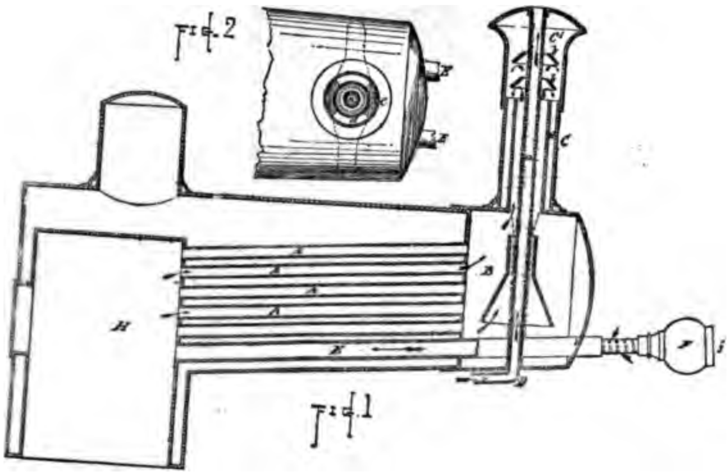


Fig. 1

R. Hawks & H. L. Payne—Patented Sept. 17, 1872.

EXHIBIT—99.

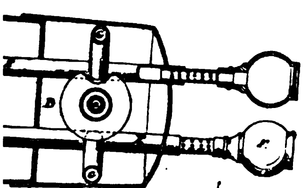


Fig. 3

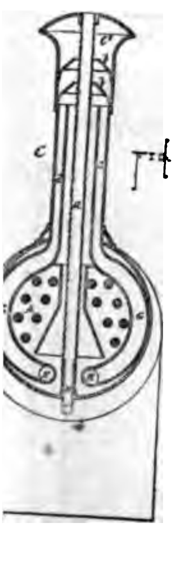
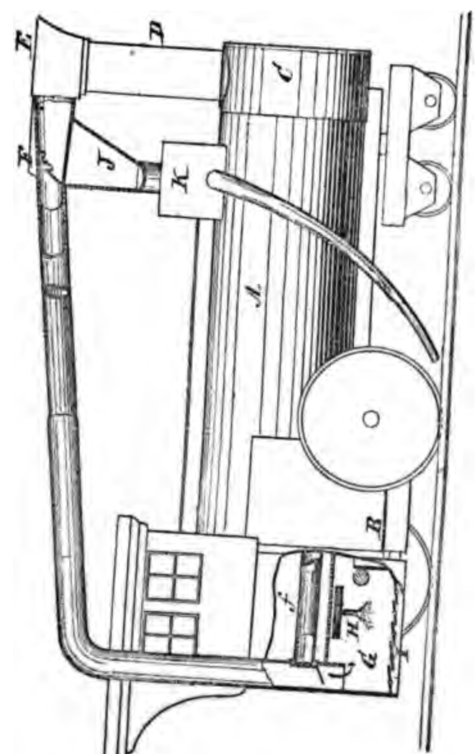


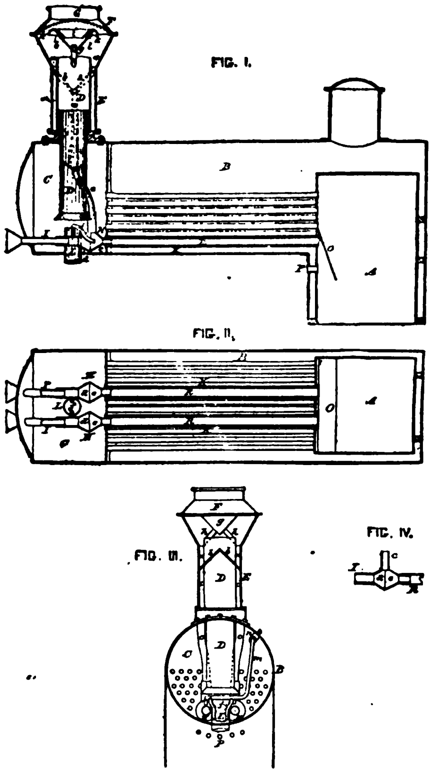
Fig. 4

EXHIBIT—100.



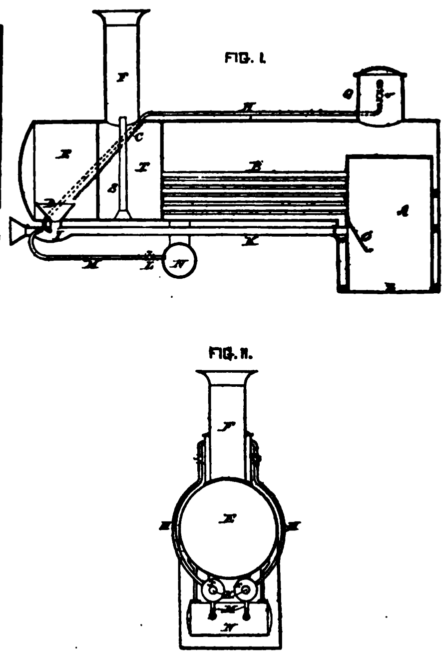
W. Martin—Patented December 3, 1872.

EXHIBIT-101.



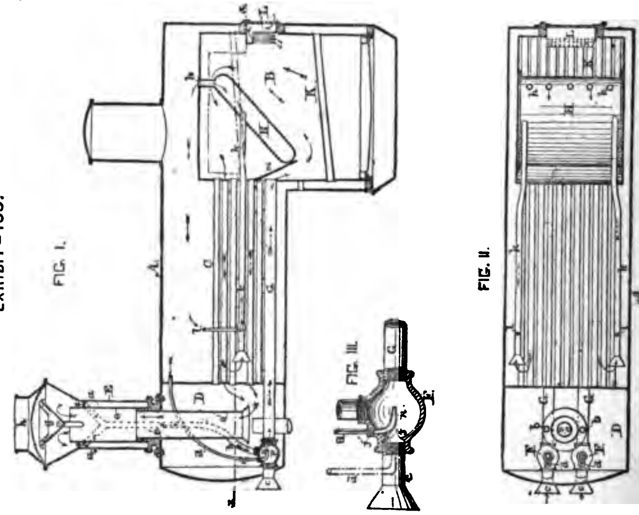
A. Berney—Patented October 12, 1880.

EXHIBIT-102.



A. Berney—Patented April 5, 1881.

EXHIBIT-103.



A. Berney—Patented April 12, 1881.

EXHIBIT – 104.

Fig. 1.

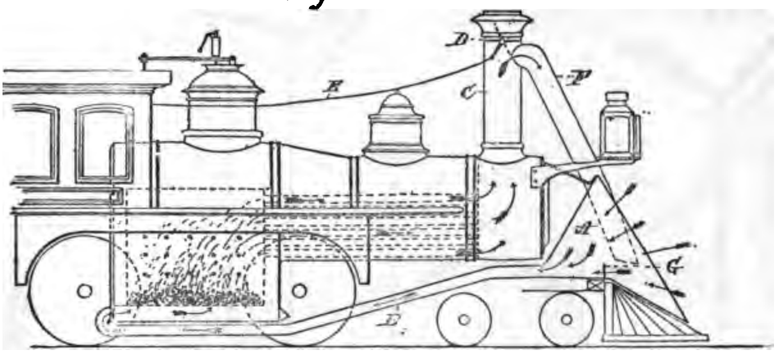
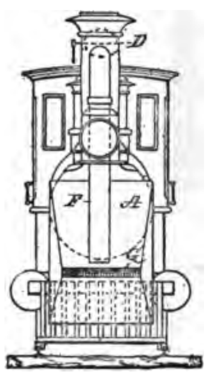
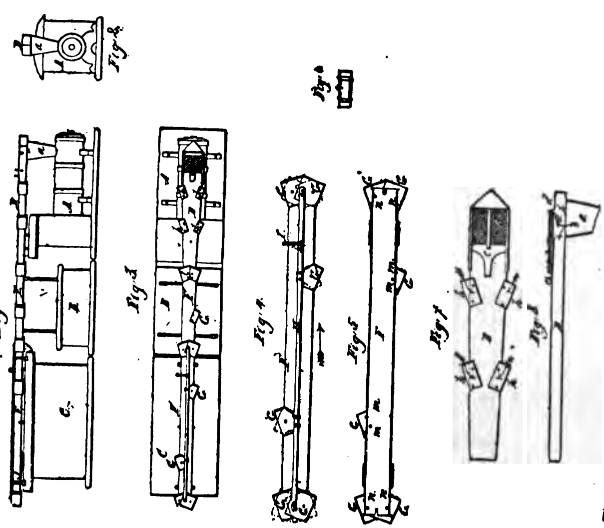


Fig. 2.



E. L. Brady—Patented January 23, 1883.

EXHIBIT – 105.



L. P. Teed—Patented August 7, 1860.

EXHIBIT-106.

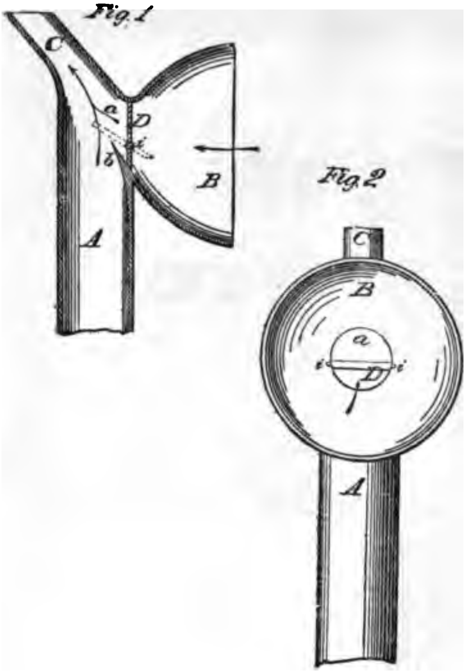
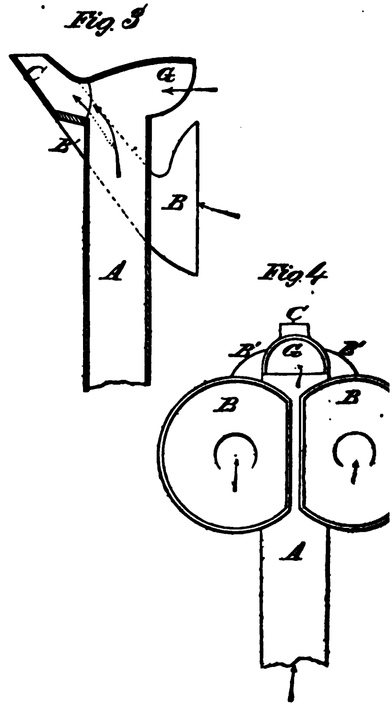


EXHIBIT-106.



T. Lunston—Patented November 3, 1874.

EXHIBIT-107.

FIG. II.

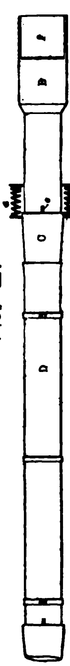
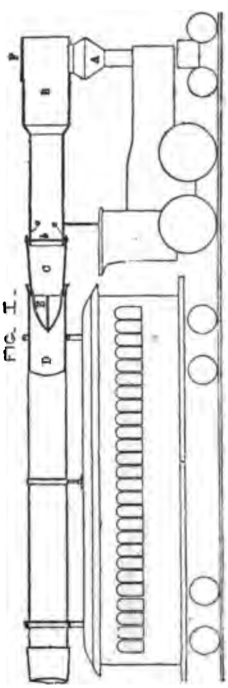
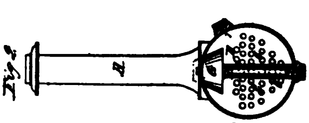


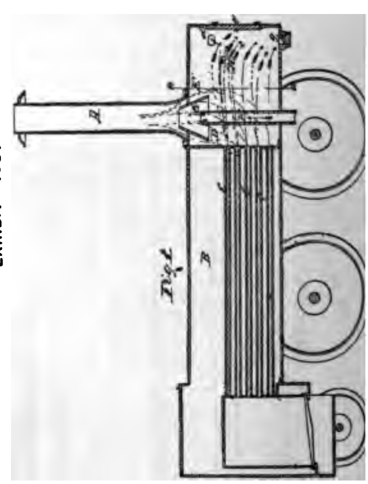
FIG. I.



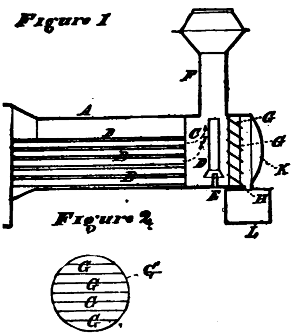
J. J. Frey—Patented November 5, 1878.

EXHIBIT-108.



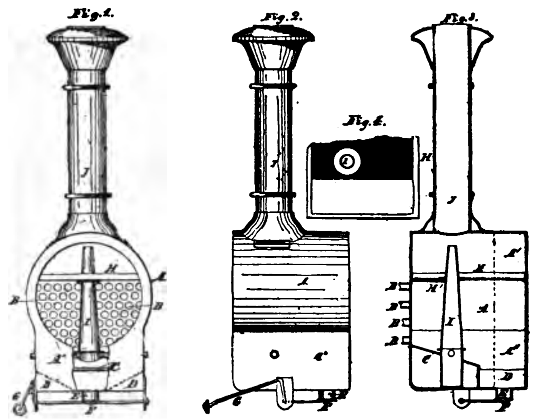


EXHIBIT–109.



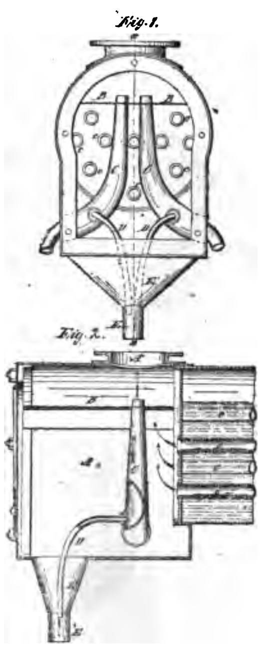
Smith—Patented May 22, 1877.

EXHIBIT–110.



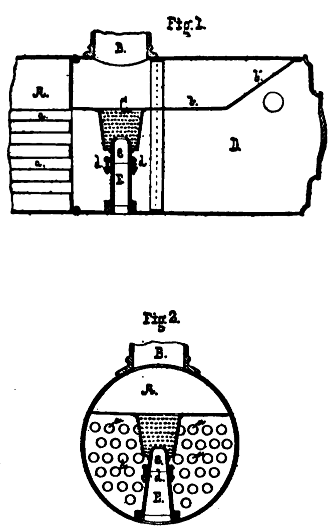
J. Hovey—Patented April 7, 1863.

EXHIBIT–111.



H. Congdon—Patented Aug. 23, 1864.

EXHIBIT–112.



A. J. Cromwell—Patented June 21, 1871.

EXHIBIT-113.

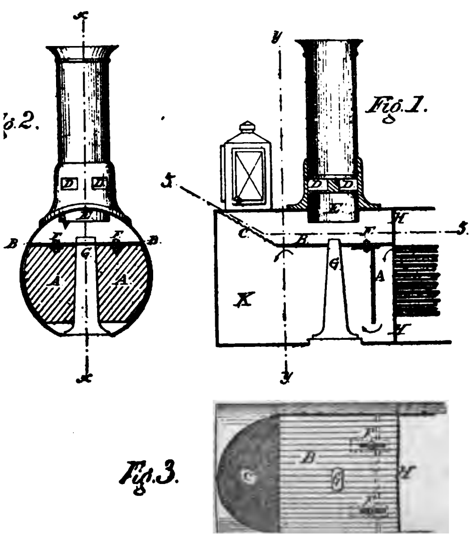


EXHIBIT-114.

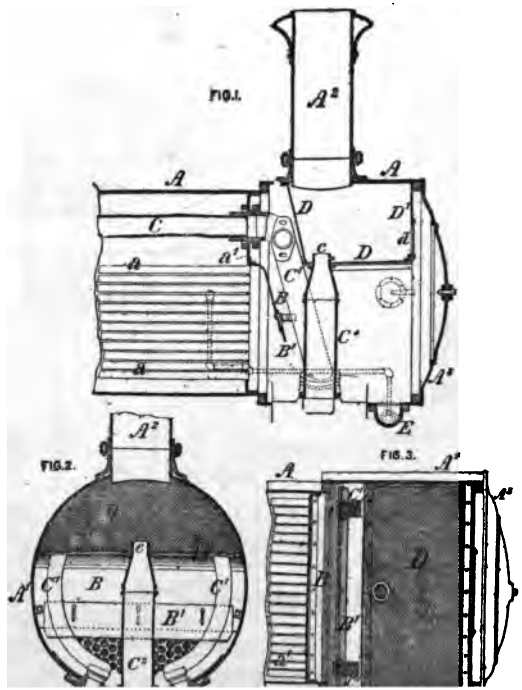


EXHIBIT-115.

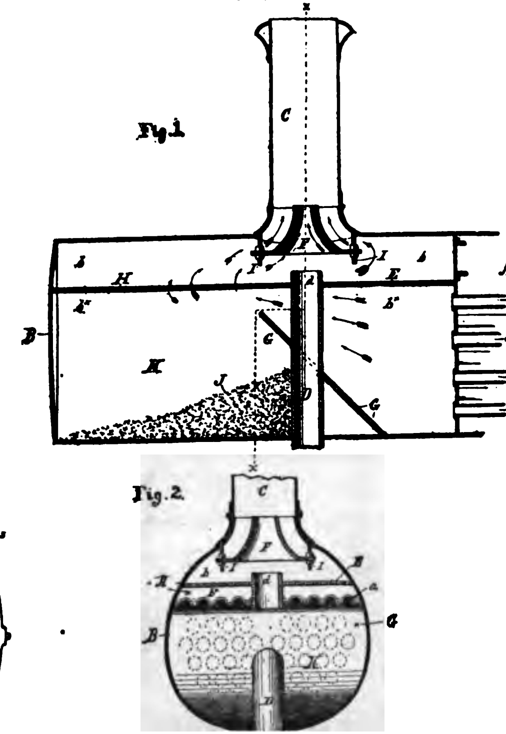
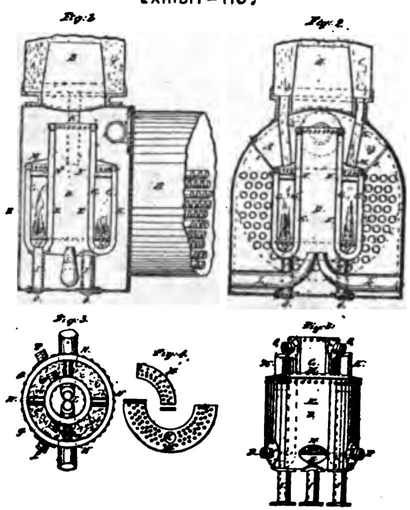
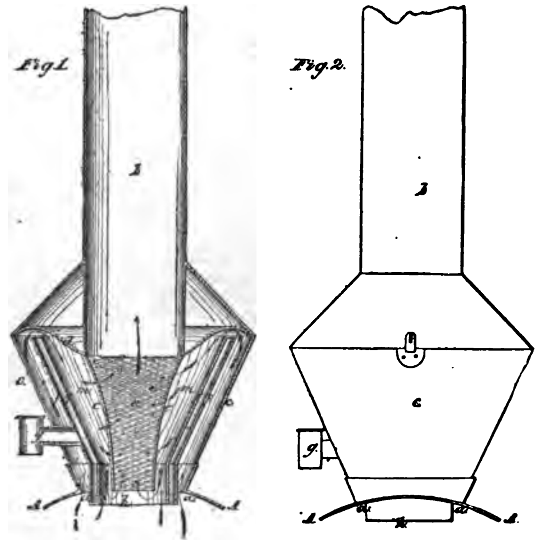


EXHIBIT-116.



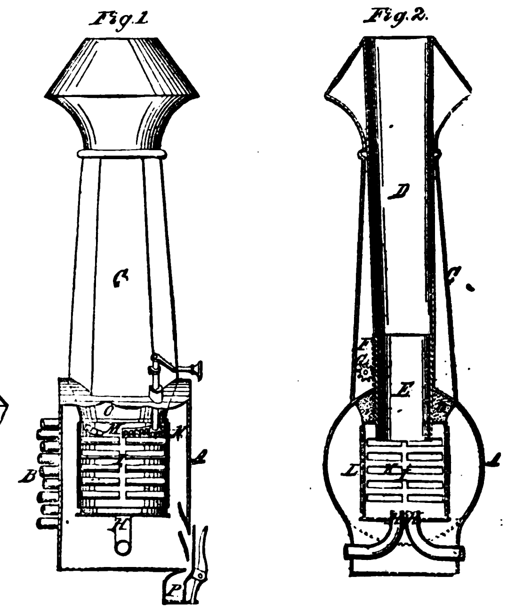
D. Matthew—Patented December 6, 1853.

EXHIBIT-117.



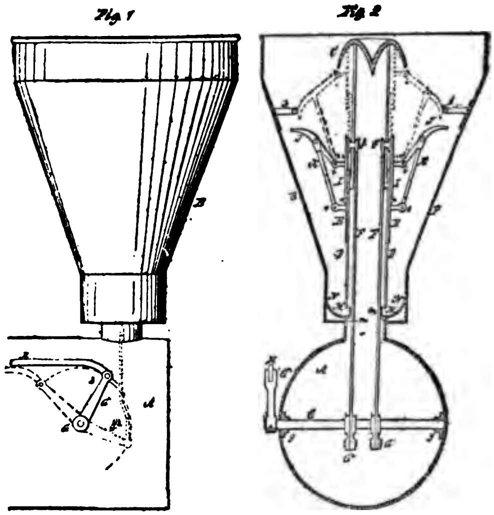
R. A. Wilder—Patented October 31, 1834.

EXHIBIT-118.



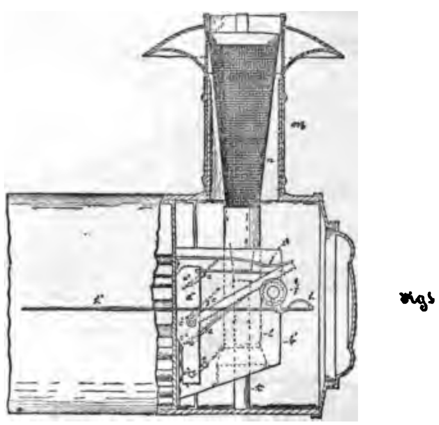
J. L. Vanclain—Patented August 20, 1861.

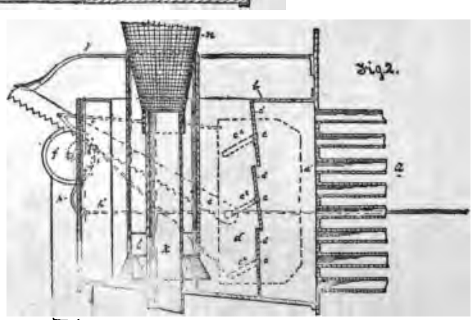
EXHIBIT—119.



H. R. Gillingham—Patented September 1, 1863.

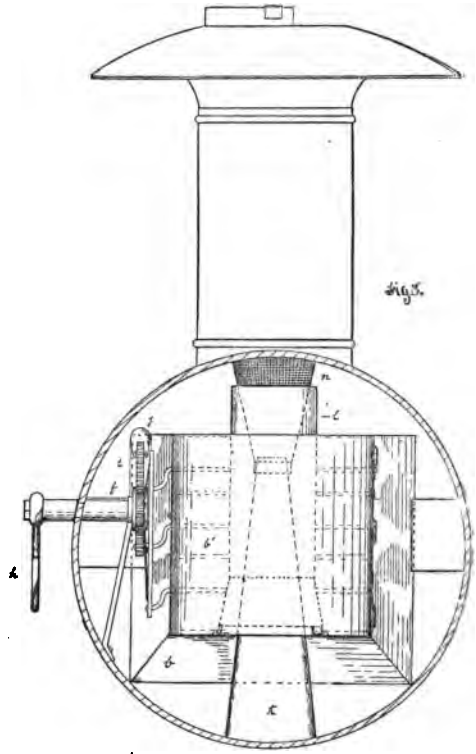
EXHIBIT—120.



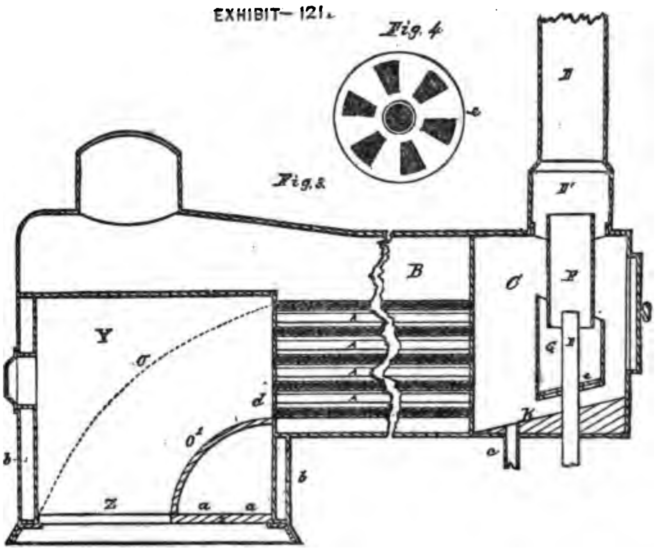


J. E. Sampel—Patented May 18, 1880.

EXHIBIT—120.

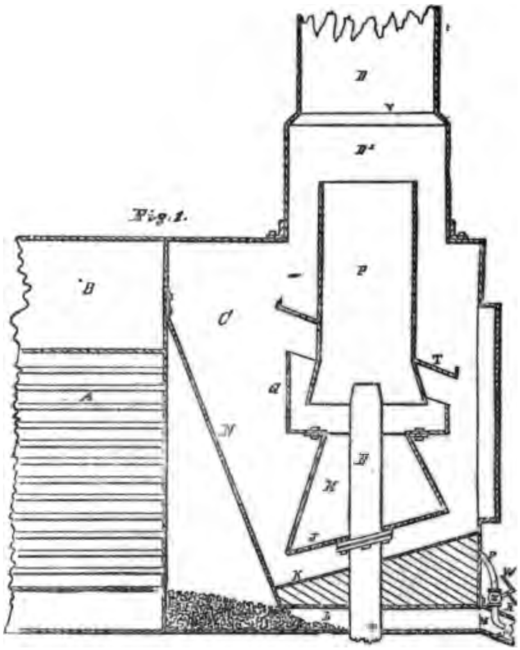


EXHIBIT—121.

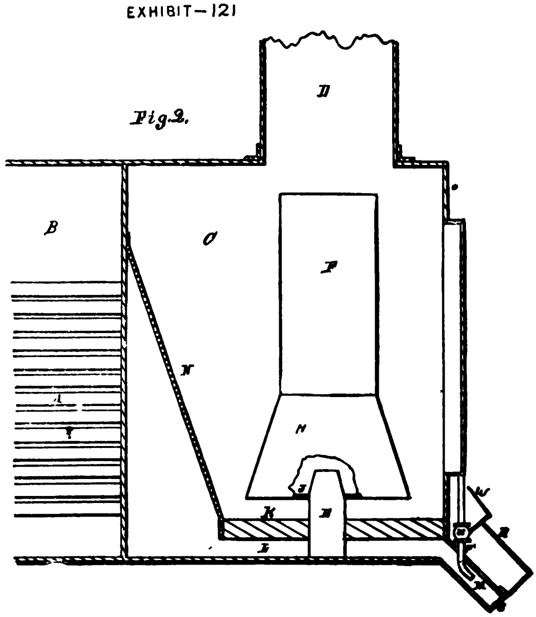


J. D. Brown—Patented February 22, 1881.

EXHIBIT—121.

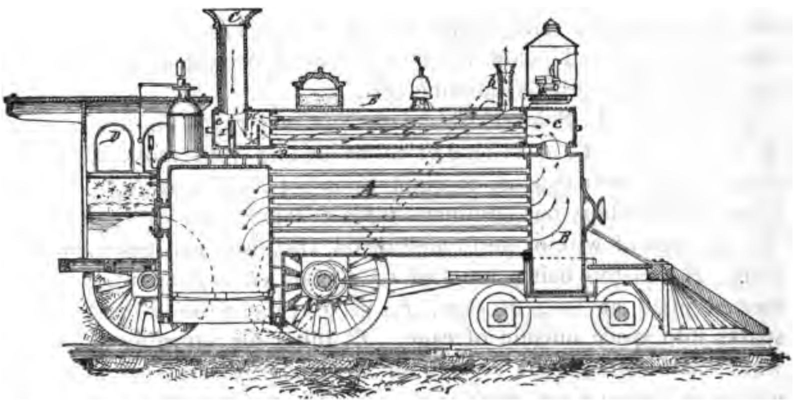


EXHIBIT—121



EXHIBIT—122.

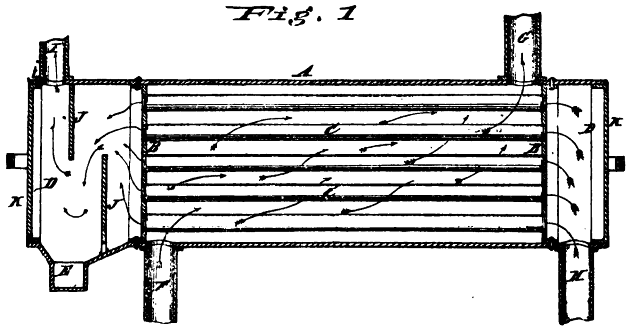
Fig. 1



W. H. Richardson—Patented April 27, 1875.

EXHIBIT—123.

Fig. 1



W. H. Richardson—Patented January 4, 1876.

The following is a description of the most important of the foregoing engravings:

EXHIBIT 2.—Wm. Schultz, March 31, 1836. A conical swell is placed in the chimney above the smoke box. At the top or base of the inverted cone is placed a wire gauze. Above this is a similar cone, its base resting upon the gauze and joining with the base of the lower inverted cone. The exhaust pipe of the engine passes centrally through the gauze. Outside of the double cone are flues provided with dampers, said flues connecting with the chimney above and below the cone. The flues and dampers are used when the engine is standing still.

EXHIBIT 3.—L. Phleger, No. 1417, Nov. 25. 1839. *A*, chimney. *B*, smoke box. *C*, short pipe or collar leading from smoke box to drum, D. Lower end, *A*, of chimney is not connected with drum or with smoke box, but terminates three or four inches above plate, E. *F*, cage of wire or perforated metal, the lower end resting on plate, *E*, its top being attached to a plate, *G*. *J*, annular perforated plate at base of cage, *F*, to prevent passage of larger sparks into space outside of cage. *H*, tubes for returning sparks which pass through the cage to smoke box. *K*, draft tubes for use when engine is not working.

EXHIBIT 4.—Reaney & Naglee, No. 1447, Dec. 28, 1839. *A*, connection of smoke pipe to smoke box. *B*, first section of smoke pipe. *c*, second section. *D*, flaring top section. *E*, exterior pipe. *F*, hood or cap of same. *C*, top metal plate. *G*, perforated metal cones. *d d*, rim above top plate of cap. *H*, sliding cylinder for increasing height of rim for enlarging the surface for escape of draft and steam. Ashes fall into space between chimney and exterior casing, *E*, whence they may be removed through lower door. Invention consists in the use of a number of inverted cones. Also, in the use of a projecting rim for increasing draft.

EXHIBIT 5.—E. May, No. 17,884, July 28, 1857. *A*, smoke box. *B*, spark arrester. *C*, steam exhaust pipes. *D*, chimney extending down into smoke box. Spark arrester consists of wire cage having opening, *a*, in its front, and sliding door, *b*, so adapted as to be capable of covering or uncovering said opening. Door may be joined to hand lever, *c*, extending through side of smoke box.

EXHIBIT 6.—A. S. Sweet, Jr., No. 38,992, June 23, 1863. *A*, smoke box. *B*, exhaust pipes. *C*, cast plate. *D*, gauze cylinder. *E*, contracting ring. *G*, gauze case. *H*, metal ring. *I*, wire casing. *K*, base of exterior stack. *L*, continuation of same. *J*, chimney. Contracting ring, *E*, retards ascending steam, and sensibly moderates the force with which the gases are drawn in through *D*. The opening at *A* is also contracting.

EXHIBIT 11.—G. Holbrook, Nov. 23, 1835. *A*, cylinder. *F*, chimney. *G*, smoke arch. *H*, doors. *O*, flaring flange. *B M*, outer frame or netting. *E*, post. *N*, inverted cone. *I*, coarse netting. *J*, fine netting. *K*, finer netting. *L*, finest netting. *C*, stanchions.

EXHIBIT 12.—W. Duff, No. 521, Dec 20, 1837. *a*, smoke box. *b*, jacket. *c*, wire screen. *d*, rod to raise screen. *e*, cleaning door. *f*, smoke pipe. *g*, Venetian screen. *h*, annular deflectors of Venetian screen at an angle of 45 degrees. *k*, deflectors similar to those. *i i*, inverted cone. Invention designed to arrest and extinguish sparks, produce draft, and cure smoking in chimneys.

EXHIBIT 13.—J. Oberhausser, No. 618, Feb. 24, 1838. *A*, chimney. *B B*, enlargements of same. *c c*, partitions. *D D*, draft flues. *E E E′ E′*, gauze sheets. *a a*, perforated curved ends of tubes, *D*. The larger sparks or cinders are arrested by the curved ends, *a a*, and deposited upon partitions, *c*, the smaller particles being arrested by the gauze sheet, *E*, and deposited upon the said partitions.

EXHIBIT 14.—B. Briscoe, No. 1037, Dec. 15, 1838. *A*, chimney. *B*, inverted sheet iron casing or spark receiver. *C*, top sheet iron ring. *D*, part of casing in which sparks are collected. *E*, conical disk at apex of inverted wire cone, *F*. *a a*, cleaning doors.

EXHIBIT 15.—R. French, No. 2131, June 16, 1841. *A*, chimney. *B*, case surrounding same. *C*, hoops or bands made in section in the form of a frustrum of a cone, uniting at *a*, and forming a continuous perforated surface extending across the case *B*. *D*, cap under which smoke, etc., escapes laterally. *E*, space for collection of sparks. *G*, smoke box. The bands, *C*, produce a continuous perforated surface of great extent, between which concentric circular spaces are left.

EXHIBIT 16.—J. V. L. Hoagland, No. 2496, March 18, 1842. *A*, chimney. *A'*, bent top of same. *B*, outside casing or spark collector. *C*, semi-circular casing for giving sparks downward direction as indicated by arrows. *D*, deflector plate against which the sparks strike at an angle. *E*, space for collecting sparks. *F*, cleaning opening. *G*, wire netting to arrest lighter sparks and throw them through opening *H*, which is so arranged as to carry them back of the inside funnel out of the influence of the exhaust steam.

EXHIBIT 17.—Keagy & Shimer, No. 2588, April 29, 1842. *A*, chimney. *A'*, flaring top of same. *B*, inverted cone of perforated sheet metal. *C*, outer case for collecting sparks. *D*, lower receptacle for sparks, into which they pass through the tube, *E*. *F*, inclined plate for directing course of sparks. *G*, metal rim connecting outer case, *C*, and cone, *B*. *a a*, space around top of chimney. *b*, zone or belt of perforations in outer case, *C*. *H*, outer continuous rim surrounding zone or perforations, *b*. The exhaust steam being directed up the chimney in the ordinary manner, the larger portion of the draft will escape through the perforations in the cone, *B*, while the sparks will pass up on the outside thereof, and when they arrive at the upper edge of the chimney, there being an additional escape through the perforated part of the outer case at *b*, the sparks and ashes will be directed towards these perforations, when they will fall into the space between the chimney and the outer case and be deposited in the receptacle, *D*.

EXHIBIT 18.—James Eckler, No. 2808, October 7, 1842. *A*, chimney with closed top. *B*, outer shell. *D*, pipes for escape of sparks. *C*, screen. *k*, exhaust pipes. *n C o*, screen of finer texture. *L*, braces at open bottom of screen, *C*. *h*, cleaning door.

EXHIBIT 19.—S. Sweet, Jr., No. 4715, August 26, 1846. *A*, chimney. *B*, outer case. *B'*, cylindrical bottom plate. *D*, cleaning door. B^3, cylindrical part of outside case. *E*, heart-shaped cap or bonnet over top of smoke pipe for turning sparks downward in the bottom of the case. Sides of heart, *E''*, consist of reticulated wire or metal gauze. *F*, circular concave partition plate for guiding sparks to bottom of case. *G*, pipes extending from top of case to bottom of concave plate, *F*, covered with gauze at *g''*. Course of sparks is shown by arrows.

EXHIBIT 20.—S. Sweet, No. 10,172, October 25, 1853. *A*, smoke pipe. *B*, outer case. *C*, inclined partition. *D*, spark receptacle. *E*, cone or deflector. *J'*, braces. *H*, eight reticulated frustrums of cones, each having flange attached to rim, *a'*, ribs, *b'*, and rings, *c'*. *I*, central valve opening. *L*, lever. *b*, fulcrum. *M*, rod for raising or lowering the wire gauze valve, *K*, to vary draft. It is claimed the invention will prevent the escape of sparks and present sufficient draft surface for any emergency, and also enable the production of extra draft when necessary. When valve, *K*, is lowered greatest draft is given.

EXHIBIT 32.—Smith & Van Lone, No. 793, June 20, 1838. The smoke, sparks, and steam pass up the pipe, *K H E E*, striking against the sides of the cone, *B C*, and are forced beneath the funnels, *E F*. The sparks by their gravity are separated from the smoke and steam, and fall to the outside pipe, and are shaken by the jar of the engine through the pipe, *N I*, into the smoke box. *L G*, clearing door to prevent clogging of pipe, *N I*.

EXHIBIT 33.—N. Turbutt, No. 1,425, Dec. 7, 1839. *A*, grate in a vertical cylinder, *I*, bolted to top of ordinary smoke box, *K*. *B*, inverted funnel. *C*, chimney. *D*, horizontal plate surrounding base of chimney. *E*, cylindrical case resting on plate, *D*. *F*, inner concentric case with solid top and open bottom. Large cinders are arrested by grate, *A*. Small sparks are received against top of inner case, *F*, and thrown upon plate, *D*. The smoke escapes around the bottom edge of case, *F*, passing out through the annular space between the casings, *E* and *F*.

EXHIBIT 34.—C. Abos, No. 11,057, June 13, 1854. *A*, outer chamber mounted on fire box, *B*. *C*, central draft passage. *D*, taper pipe. *E*, central conducting or return pipe. *F*, self-closing hinged valve. *G*, stays or braces. *H*, annular space. Exhaust steam and sparks rise through space, *H*, as shown by arrows, 1, and are thrown into flaring mouth, *E*, as indicated by arrows, 2, and their gravity and the pressure of the exhaust steam cause valve, *F*, to open, the sparks passing into the fire box.

EXHIBIT 38.—J. Stimpson, No. 161, April 17, 1837. Termed a draft accelerator or centrifugal spark catcher. The principle consists in using a spiral flue whereby a centrifugal force shall be obtained between the furnace and the top of the chimney to prevent

the escape of sparks therefrom. It is claimed that the centrifugal force of the volume of heated air against a jacket passing up the central pipe as high as the top of the spirals, will produce a heat, create an extra draft, and consume the smoke and soot.

EXHIBIT 39.—W. T. James, No. 688, April 13, 1838. The smoke and sparks ascending the chimney, escape through spiral openings and take a circular direction under a flange. The sparks being of greater specific gravity than the smoke, their centrifugal force impels them through the smoke against the inner side of the tube which surrounds the smoke pipe where they circulate until they drop to the bottom of the tube.

EXHIBIT 40.—S. Gibson, No. 5,123, May 22, 1847. When the engine is in motion the steam, by acting on the flanges, *i*, at the bottom of the inner pipe, gives a rapid revolving motion to the shaft, *m n*, carrying the inner pipe, *J K L*, and then passing with the smoke, etc., into the spiral flue formed by the inner pipe, *J K L*, and spiral planes, *I O K P*, keeps up and increases the motion; issuing out of the top of *J K* of the inner pipe, whence the sparks and cinders are thrown with violence against the inside of the outer pipe, or its cap, *A M C*, and then falling down on the partition plate, *q R*, are discharged by the oblique pipe, *R S*, downward upon the road. *T* is a chimney to be used when the engine is not in motion, opened and closed by a valve, *v*.

EXHIBIT 41.—J. A. Cutting, No. 6,559, June 26, 1849. *a*, smoke pipe. *b*, inverted funnel-shaped deflector to reverberate the products in a downward direction. *c*, series of radial inclined or curved planes forming a series of chutes for passage of products of combustion, causing products to revolve around the chimney and gradually spread out towards the casing, *d*. *e*, radial apertures in diaphragm *f*, through which much of the solid matter is thrown to a receptacle, *g*. *h*, inclined flanges on one edge to facilitate deposition of sparks. As there is no escape at the bottom for the gases, they take by reason of the rotation an outward upward direction through second series of inclined chutes, *i*, formed like first series, and on a level therewith, but inclined or curved in such a manner that the direction of the rotation of the gases is reversed, so that below the series of inclined chutes there are two currents, an inner one in one direction, and an outer and upward one in the opposite

direction. *j*, jacket surrounding series of chutes; *i*. *k*, vertical apertures through which the circular motion of the outer current forces the remaining particles of solid matter into surrounding receptacle, *l*, from which they are removed through door, *m*. *o*, open circular space covered by gauze for the escape of the lightest gases.

EXHIBIT 42.—Radley & Hunter, No. 7,040, Jan. 22, 1850. *a*, chimney. *b*, funnel. *c c c*, triangular plates forming series of compartments or channels. *d*, openings in sides of compartments *c*. *e*, angular caps guarding openings, *d*, except top opening. Openings are made around base of funnel, *b*, to form communication from chambers, *c*, to space, *f*, one of which openings is shown at *i*. The side of the chamber, *c*, in which the openings, *d*, are made is curved, so that the spaces or channels 1, 2, 3, etc., are spiral, and the currents of smoke, gas, etc., as they pass through are made to impinge against the side containing the openings, *e*. As the sparks are more ponderable than the gases with which they are intermixed, they are consequently dashed against the side of *c*, coming opposite the openings, *d*, and are urged within the chamber both by their own momentum and the pressure of the current. The angular caps, *e*, check the upward motion of the sparks. The sparks thus discharged through the holes, *i*, into the space, *f*. *g*, funnel or cone. The construction, therefore, consists of two funnels of different diameters placed one within the other, the space between them being divided into compartments, *c c*, and 1, 2, 3. The outer caps, *k k l*, are placed upon the top of *b* and *f*. *p*, short pipe. *o*, apertures. Pipe *p* may be elevated or depressed to regulate draft. Sparks not arrested by the chambers, *c*, are caught at the several openings *o*, and pressed into the space formed by the divisions, *m*, where they are removed from the influence of the external current and fall by gravity into the space, *f*.

EXHIBIT 46.—S. Newhall, Jr., No. 585, Jan. 27, 1838. *A*, boiler. *B*, chimney into which the engine exhausts. *C*, funnel for carrying off smoke. *D*, box containing a small quantity of water to receive and extinguish sparks. *E*, conical funnel to direct sparks to box, *D*. *H*, tube to supply or empty box, *D*. *G*, cleaning door.

EXHIBIT 47.—S. Leonard, No. 1,038, Dec. 15, 1838. *A*, funnel. *B*, vessel containing water and receiving sparks having lower

cleaning apertures. *C*, cone or bell. *D*, driving pulley on the cone or bell shaft, worked by the engine. *E*, wings or fans attached inside of cone or bell. *F*, frame on which cone or bell is hung. The cone or bell with its wings revolves over the funnel, causing draft and extinguishing sparks by throwing them into the water.

EXHIBIT 48.—J. Finlay, No. 1,042, Dec. 28, 1838. The invention consists in a fan wheel revolving through water contained in a water case, thereby extinguishing and arresting the escape of sparks which are thrown downward into the water case, the smoke only escaping from the chimney.

EXHIBIT 49.—D. Ritter, No. 1,861, Nov. 26, 1840. The invention consists in conducting the sparks and dust from the top of the chimney horizontally, or otherwise, and depositing them in a cistern or reservoir with or without water, whereby the sparks will be extinguished and the dust absorbed, while the smoke only escapes. The cistern is placed on the arch over the head of the fireman and may be variously constructed.

EXHIBIT 50.—W. P. McConnell, No. 1,892, Dec. 10, 1840. *A*, circular case in end of smoke box, *L*. *B*, revolving fan. *C C'*, conducting pipe. *D*, perforated plate. *E*, water vessel. *N N*, water outlets. *K*, inclined circular rim to deflect sparks into vessel, *E*. *G*, cylindrical vessel surrounding *E*. *I*, chimney. *J J*, exhaust pipes. *H H*, tubes projecting downward from *G*. When the vessel, *E*, is full, the sparks flow into the space, *F*, and are carried downward by the tubes, *H*.

EXHIBIT 51.—Z. Wilbar, No. 2,901, Jan. 10, 1843. *A*, chamber placed upon top of ordinary boiler. *B*, valve to admit water. *C*, valves for discharging water with the extinguished sparks. *D*, water supply pipe connecting with tender. *E*, stop cock at level of water. *F*, scrapers. *G*, horizontal partition. *H*, lower apartment. *J*, upper space. *K*, chimney. *L*, engine exhaust pipes. *M*, short horizontal partition, containing semi-conical or semi-funnel shaped spark arrester, *N*. *O*, collar rising above the level of water in chamber, *H*. The smoke and sparks enter the chamber, *H*, at *O*, strike against the bottom of the partition, *G*, many of the sparks falling into the water where they are extinguished, the smoke and remaining sparks passing into the funnels, *N*, and around the

inclined end of the partition, *G*, to the space, *J*, thence into the chimney, *K*.

EXHIBIT 52.—J. A. Roebling, No. 2,958, Feb. 16, 1843. *A*, smoke box. *B*, inner chimney. *C*, exhaust pipes. *D*, inner surrounding case with closed top. *E*, water cistern. *F*, outer ascending flue terminating in an ordinary chimney. *H*, gauze partition leaving open space at *K*. F', downward extension of flue. *L*, space into which the sparks that do not fall immediately into the water will enter. F' F^2, wide lower end of outer case, *F*, to form cistern. This invention follows the construction of Russian stones, and is designed to obviate objections urged against other spark arresters of top-heaviness. The novelty is stated to consist in the arrangement of the downward flues and draft and water cistern, whereby the sparks will at once be hurried into the water without being checked by wire gauze, or impeding the draft in any way.

EXHIBIT 64.—Cutting & Butterfield, No. 5,163, June 19, 1847. *A*, chimney. *B*, hollow cylinder. *C*, conical thimble. *D*, extinguishing cap with double casing secured to the cylinder, *B*, by arms, *i*. The sides of cap, *D*, are perforated. *f*, pipe connecting with the force pump of engine. *A*, water reservoir is formed around thimble, *C*, within cylinder, *B*. *m*, pipe to regulate height of water. *e e*, wells having sliding gates at their lower ends from base of reservoir for removing sparks. Water is forced in jets by force pump of engine through pipe, *f*, through the sides of cap, *D*, the jets extinguishing the sparks as they emerge from the cap, *D*, and forcing them into the water reservoir, smoke escaping around the cap, *D*, through the space between the same and the lining, *k*, into the atmosphere. The open mouth of the air chamber between the cylinder, *B*, and lining, *k*, retards the upward course of the sparks should any fail to be extinguished by the jets of water discharged from the cap, *D*.

EXHIBIT 65.—H. Chase, No. 15,645, Sept. 2, 1856. Invention consists in arresting carbon in a chimney or separating it from volatile products of combustion passing through said chimney. *A*, chimney. *B*, water reservoir. *C*, dome plate. *D*, pipe communicating with cistern or force pump. *E*, cylindrical box. *F*, series of pipes separating stream into numerous jets. *I*, discharge pipe.

EXHIBIT 74.—W. Knight, No. 1,378, Oct. 26, 1839. *A*, smoke pipe. *D*, fire box. *B*, metal pipe. *S S*, space closed at top, *a b*. Pipe, *B*, open at top and closed at bottom where the exhaust pipes, *c*, enter. Pipe, *B*, made of wire gauze or perforated metal. Sparks which may pass into pipe or extinguisher, *B*, through its perforations are too small to be productive of injury. The larger sparks either burn out or fall back into the smoke box, whence they may be removed.

EXHIBIT 75.—L. Phleger, No. 1,778, Sept 10, 1840. *A*, chimney. *B E*, perforated cone having imperforate part, *D*, and cylindrical portion, *C*. *F*, outer case. *G*, escape for heated air. *H H'* elbow pipes. *I*, top of cone having hinged cover, *J*, worked by rod, *k*. *L*, bottom of perforated cone opening into space, *M*, having elbow pipe, *N*, leading into the spark receptacle, *O*, having cleaning door, *P*. Cover, *J*, is closed when engine is working. When engine is acting, the direction of the draft is downward between the chimney and the perforated cone. The sparks are driven by the force of the steam into the space, *M*, and thence through the elbow pipe, *N*, into the receptacle, *O*. The gaseous products of combustion pass through perforations into the flue space surrounding them, and the pipes, *H H'*, into the atmosphere.

EXHIBIT 76.—J. Marks, No. 21,687, Oct. 5, 1858. *a*, smoke pipe. *b*, petticoat pipe consisting of series of tapering overlapping tubes. *d*, cylinder of wire gauze. *e*, short perforated metallic shield to protect wire net work in front of boiler tubes. Sparks and other unconsumed products of combustion pass between wire cylinder, *d*, and smoke pipe, *a*. The upward passage of the exhaust steam partially exhausts air in petticoat pipe, producing and varying the intermittent draft, which first attracts sparks against the wire net work, *d*, and then releases them. This alternate attracting and repelling of sparks takes place every time the engine exhausts until they are pulverized or consumed.

EXHIBIT 77.—Peaslee & Lilley, No. 26,373, Dec. 6, 1859. This invention consists in providing a perforated spark and smoke cone within the chimney stack proper, and forcing or drawing all the products of combustion through the perforation by a centrifugal action given to said products by means of a continuous current of exhaust steam passed up along the outside of the perforated cone, and between it and the outside of the chimney.

EXHIBIT 78.—Charles P. Noble, No. 39,493, August 11, 1863. The cap of the stack is provided with a globular enlargement, and an inner deflecting cone, both studded with projections, against which the sparks impinge on their way to the contracted upper orifice.

EXHIBIT 89.—Longmire & Brooke, No. 1,681, July 10, 1840. *A*, boiler. *B*, fire box. *C*, smoke box. *D*, one of steam cylinders. *E*, smoke pipe, the damper to be closed when engine is in action. *F*, flues from smoke box connecting with flue, *G*, under boiler, and uniting with space specially prepared at lower end of fire box, *B*, or with ash pan. Exhaust steam passes from cylinders into flues, *F* and *G*, which now take the place of the ordinary chimney, *E*. Bottom of space or ash pan is provided with gauze, *b*. *c c*, water box. The water in the box, *c*, is heated and used for supplying the boiler, flowing to and from the box through the pipes, *d d'*.

EXHIBIT 90.—J. Montgomery, No. 4,921, Jan. 7, 1847. Sparks are thrown back to furnace through tube, *e*, by fan, *a*, revolved by waste steam through pipe, *d*, or by other means. *f*, is perforated screen or casing to prevent exit of sparks.

EXHIBIT 96.—D. Matthew, No. 1,849, Re-issue No. 356, Feb. 26, 1856. A part of the invention consists in turning the sparks from the top of the chimney inwardly into the inside of a conical or trumpet mouthed tube; and in conducting the sparks and a portion of the gas, with atmospheric air, into the furnace to be consumed.

EXHIBIT 97.—B. F. Blood, No. 18,951, Dec. 29, 1857. *L*, fan blower. *R*, orifice for escape of smoke. *T*, pipe for air blast. *H*, nozzle for gas and air. *G*, scuttle at front end of fire-box. *I*, lift pipe for regulating exhaust.

EXHIBIT 105.—L. P. Teed, No. 29,531, Aug. 7, 1860. *A*, locomotive. *B*, tender. *C*, first car. *a*, chimney. *D*, conducting tube, separated from chimney by perforated plate, *b*, figure 8. *c*, sliding door in top of conducting plate. *d*, gauze plate. *e*, valve. Arrangement of valve is such that when door, *c*, is pushed over opening the valve is raised, leaving free communication between chimney and pipe, *D*. When door, *c*, is opened the valve, *e*, will close said communication. *h*, inclined shields, mouths of which catch the air, see figure 7. *E*, conducting pipe on tender, having expanding mouth, *i*, to receive end of tube, *D*. *F*, conducting

pipe above each car of the train, hung losely between pins, *j j*, and resting on springs secured to top of car. *m*, openings. *G*, shield, hinged so that it may be turned to two positions shown in figure 4. Shields are moved with respect to direction of movement of the train. *n n*, similar openings, having movable shields. Series of shields are connected by rod, *H*, so that they may be moved by arm, *I*, passing through the car. When train is in motion door, *c*, figure, 8, is closed and valve, *e*, raised, so that the smoke and such of the sparks as can escape through the perforated plate, *b*, pass into conducting pipe, *D*. Invention does not consist, broadly, in conducting sparks to rear of train, which is old, but in the conducting pipes with openings and hinged shields simultaneously operated by a rod, the whole arranged for conducting sparks rearward.

EXHIBIT 108.—J. Thompson, No. 28,520, May 29, 1860. *A*, chimney. *B*, boiler. *C*, smoke tubes. *D*, smoke box. *E*, blast pipe. Line, *a a*, exhibits position of front of smoke box as ordinarily made. Smoke box is extended beyond this line. *E'* shows outer boundary of current of smoke and gases discharged from pipes, *C*. *d*, pipe clearing opening. *e*, its door. *f*, raking port. *g*, discharge port. *h*, spout leading through frame. *G*, hollow conical deflector placed around discharge mouth of blast pipe. Deflector receives upon its external surface and condenses steam that falls back from the blast, scattering the water upon the mass of cinders, so as to extinguish the mass and make it compact, and aid in its retention in the smoke box while the engine is in motion. Invention consists in extending smoke box beyond smoke current, so that sparks or cinders discharged through the pipes, *C*, may pass out of and beyond the current of smoke, so as to be deposited in the box by the action of gravity, and not be carried up the chimney.

EXHIBIT 110.—J. Hovey, No. 38,111, April 7, 1863. *A*, smoke box. *B*, flues. Forward end of smoke box is extended about sixteen inches further than customary, as shown at *A'*, in order to give extended surface to spark arrester. Bottom of smoke box is extended below flues, as shown at *A''*. *C D*, inclined planes for facilitating discharge of cinders through outlet, *E*. *F*, valve having cord or rod extending back to cab. *H*, wire screen constituting spark arrester. *H'*, deflecting plate stretched across from side to side, to deflect sparks into the extended portion, *A*, of

smoke box. *I*, exhaust pipe. *J*, stack entirely unobstructed, the screen, *H*, arresting cinders which fall back upon inclined planes, *C D*, to bottom of smoke box. Screen, *H*, checks sudden draft of air through fire box and flues, and while draft produced by exhaust is sufficient to insure good combustion of the coal, it is not strong enough to draw up the cinders through the flues to any great extent. It is stated that in the use of the ordinary smoke box and stack, some eight hundred pounds of cinders have been collected in the smoke box in running about two hundred miles; while with this improvement, with the same engine and the same kind of coal (bituminous) in running over the same distance, only about forty pounds of cinders were collected, thus showing, in addition to an entire freedom of annoyance from smoke and sparks by the passengers, a saving of more than seven hundred pounds of fuel for the distance named.

EXHIBIT 111.—I. H. Congdon, No. 43,898, Aug. 23, 1864. *A*, smoke arch. *B*, sieve or spark arrester. *c*, exhaust pipes. *D*, jet-pipes communicating therewith. *E'*, hopper-shaped box, having pipe, *E*, at bottom thereof. When the pipes, *c*, are exhausting, a quantity of steam passes into the jet-pipes, *D*, thence into pipe, *E*, passing out at under side of engine. When steam exhausts from pipes, *c*, into smoke arch, *A*, there is a tendency of the air to rush up through discharge pipe, *E*, to supply the vacuum, or the current which will pass up through pipe, *E*, is overcome by the steam from jet-pipes, *D*. Thus while smoke is permitted to pass up and out at opening, *A'*, sparks and cinders are arrested by the sieve, *B*, and as the discharge of the steam from pipes, *D*, produces a contrary current in direction of the pipe, *E*, the sparks and cinders descend into the box, *E'*, and thence out upon the ground through the pipe, *E*. The sparks and cinders coming within the influence of the steam are deadened and extinguished.

EXHIBIT 116.—D. Matthew, No. 10,295, Dec. 6, 1853. *A*, front of boiler. *D*, apparatus for consuming sparks and heating feed water, having concentric plates, *E* and *G*, forming water spaces. *N*, horizontal connecting pipes. Sparks are caught between plates, *G G*, and burned up on grate, *H*. *I*, pipes for supporting combustion. *M*, perforated plate covering top of spark furnace. Sparks are dropped from reservoir, *C*, through pipes, *K*. *P*, pipes

for conveying feed water to apparatus to be heated. *Q*, pipes leading from apparatus to boiler.

EXHIBIT 117.—R. A. Wilder, No. 11,830, Oct. 31, 1854. *A*, fire box. *c*, cone whose cap, *d*, leads to perforated cone, *e*. Cone *e* forms lower end of smoke pipe, *b*. *f f*, double cone. The space within double cone communicates by pipe *g*, with the boiler, and is filled with water. Smoke and heat pass from fire box partially through aperture, *h*, upwards between *c* and *f*, and underneath *d* towards perforated cone, *e*, and partially through hole, *h*, upwards through flue, *m*, by which means the smoke is made to heat the feed water in the double cone before escaping through perforated cone, *e*, into tube, *b*.

EXHIBIT 118.—J. L. Vanclain, No. 33,114, Aug, 20, 1861. *A*, smoke box. *B*, flues. *C*, external stack. *D*, exit flue. *E*, adjustable throat constituting lower part of *D*. *F*, rack. *G*, pinion used for lifting and depressing throat and varying its proximity to exhaust nozzles, *H*. *I*, perforated cylindrical box having longitudinal slots, *K*. *L*, surrounding cylindrical register operated by rack, *M*, and pinion, *N*. Screen is adjustable both as to size of individual apertures and of the entire area of smoke passage, and can be made to avoid the escape of sparks and also to act as a damper. Upper portion of screen may consist of wire gauze, *O*. *P*, trap for spent sparks.

EXHIBIT 119.—H. R. Gillingham, No. 39,727, Sept. 1, 1863. Object of the invention is to provide for the suppression of combustion in the furnace, and to graduate the heat of the fire-box and also to dispose of the sparks.

A, smoke-box. *B*, exterior of stack. *C*, deflecting cone. *D*, internal fixed chimney. *E*, extension pipe, adapted to slide up and down on *D*. *f*, internal projections connected by rods, *F*, to arms, *G''*, on shaft, *G*, turning in bearings, *g*. *G'*, arm. *H*, rod under control of engineer. *I*, pipe sliding upon *E*. In ordinary position of *E*, the pipe, *I*, is carried thereon in the manner represented, and performs no function; but when *E* is by extreme movement of arm, *G*, lifted to its fullest extent, the lifting of *E* through the last part of its movement causes pipe, *I*, to slide upwards thereon, and consequently to be elevated still faster. This is effected by additional parts represented. *e*, external lugs on *E*, and *i*, external lugs on *I*.

J, bent levers joined to *i*, *K*, links hinged to both *e* and *J*. *b*, stops. When *G′*, is thrown forward "the work in the stack sinks and the fire is urged intensely." As arm, *G′*, is drawn back, it is secured, and the arms, *G″*, rods, *F*, lugs, *f*, and movable pipe, *E*, will be correspondingly elevated. A given movement of arm, *G*, produces equal change of position of *E*. This continues until by the rising of *E* and its attachment, the outer portion of levers, *J*, meet stops, *b*. The further elevation of the outer portion of levers, *J*, being prevented, the continued elevation of *B*, thrusting upward on the link-bars, *K*, compels outer pipe, *I*, to ascend rapidly and soon to meet and fit tightly to the under face of cone, *C*. In this position of the parts, the exhaust steam ejected upwards into *D*, returns upon itself, and flows backwards into and through the furnace. *M M*, holes in sides of inner pipe, or chimney, through which sparks as soon as they are thrown down and settle in space between *B* and *D*, may, by moving with the strong current which there obtains, again find access to the interior of *B*, and may repeat the operation until destroyed by the repeated concussion and friction. *m*, shields which aid the continuance of current when exhaust is feeble and much spread, and also prevent fall of sparks by gravity from holes, *M*, in the bottom of smoke-box. *N*, curved plates for guiding sparks in their passage to the holes, *M*.

MR. J. H. RAYMOND, Western Railroad Association—For the purpose of testing the views of the Association, I would move that the Supervisory Committee be requested to print with this report the drawings submitted in the appendix. There are 115.

MR. SETCHEL—It seems to me it is only a matter of expense. Perhaps Mr. Raymond can tell us what the expense would be.

MR. RAYMOND—You can get plates of these drawings in New York for 12 cents a square inch. Of course, all the detail drawings will not go in. I should say that 4 square inches to each plate would be an ample estimate. It certainly will cost less than $100, and if it cost $500 I should recommend having it done.

MR. LAUDER—I certainly favor the adoption of that motion. I think we have got something that is valuable in this report, and if we can have these drawings incorporated in our annual report at an expense of not over $100, it seems to me that it would be money well spent, and valuable to all of us as a book of reference.

MR. SPRAGUE—I would also be in favor of that motion, but it seems to me it is hardly worth while to spend money to get those into shape

and then drop them. I think those things ought to be put in the form of a record.

MR. RAYMOND—I took the responsibility, as Secretary of the Western Railroad Association, of spending $175 in connection with this matter, and it is worth $175 to the Western Association to have those copies.

The motion was carried.

MR. LAUDER—It might be interesting to members of the Association —and I presume there are some present who may not be aware of the fact—that in our excursion this afternoon a Pullman train will be hauled by an engine that has a special arrangement in the furnace for smoke-consuming and spark-arresting, and it occurred to me while we were discussing this subject that it might be well to call the attention of the members to the fact that we have a locomotive here with some arrangement in the furnace for consuming sparks. I think the inventor's name is Walker. The device is said to have some merit; how much I do not know, but in our excursion this afternoon I shall take considerable pains to inform myself, and I hope others will, in regard to it.

MR. WILDER—I understood that the recommendation of the Committee was that a Committee should be appointed to represent this Association and take up and make experiments with certain spark-arresters, and choose one of a certain number. There is one that I have been trying lately. It has an extended smoke-box, but not as long as those, for receiving all the sparks, and then it has a lower chamber, the bottom of which is held shut by a steam cylinder working with a crank, and this lower chamber is filled with water with a deflector, coming out just above the flues on the sheets. It runs down to the deflector, and has a joint on the center which can be raised and lowered to give the requisite amount of draught. They use no netting whatever, and all the sparks are precipitated into this water. There is a float which warns the engineer, so he knows when the depository is full; and by moving a steam-cock he can open the door at the bottom and the whole of the sparks are washed out, all of them being entirely dead; and the door can be shut up again by the reverse action of the steam in the cylinder, and fills up with water again. We have had nine or ten of those engines running, and they have been running through the severe winter we had this year without any difficulty. So far I may say for the device that it has proved to be the best thing of the kind that I have seen.

MR. SETCHEL—I understood Mr. Raymond, in his report, to refer to some method of discharging the sparks out of the front end as being desirable. I would say we have got up a design of that kind on the Ohio & Mississippi Railroad, and the Western Association informs us that it is the first which has been used for locomotives. We have a pipe

running along the side of the boiler with a funnel shaped mouth, running down to the top of this auxiliary reservoir here (indicating), and also a valve hung upon hinges in the bottom, opening from the cab; and we are able to discharge the sparks either running or at stations, without throwing any on the engine, opening the water valve first, and then the spark valve discharges the sparks very quickly and very easily. We think it is a very good arrangement. I speak of it because it is the first that has been used. I do not want anybody else to get a patent on it. I want the members to have the privilege of using it if they see proper, and this will be a record that it has already been used.

MR. RAYMOND—What is the result as to smutting the engine with those sparks?

MR. SETCHEL—We have not applied the spark-pipe yet. The sparks being wet, they do not fly on the engine. But the preferable method is when you stop at a station you throw open the valve, and before you are ready to start the sparks are out.

MR. WILDER—I may say further, in regard to that Groesbeck & Wright spark arrester which I refer to, all of the very fine particles of carbon that make the products of combustion black—which we generally denominate smoke—striking into this water are immediately separated from the other products of combustion; that is, from the gases, carbonic acid gas, and carbonic oxide and hydrogen, so that the smoke that we see coming from the engine is very seldom of any color whatever. It purifies the smoke as well as clears it entirely of all gritty substances. Take it on a damp day, and if you put up your hand on the baggage car, it will not black it as it will ordinarily.

MR. RAYMOND—I beg leave to offer the following resolution:

Resolved, That the report of the Committee on Spark Arresters be referred to a special committee of seven, to be appointed by the President; and that that committee be requested to continue the investigation of this subject, and to make experiments in different parts of the country and with different fuels, with such devices as may be selected by the committee

I have made the number seven because I would like to see this examination made in seven different parts of the country, and, if possible, with seven different kinds of fuel.

The resolution was carried.

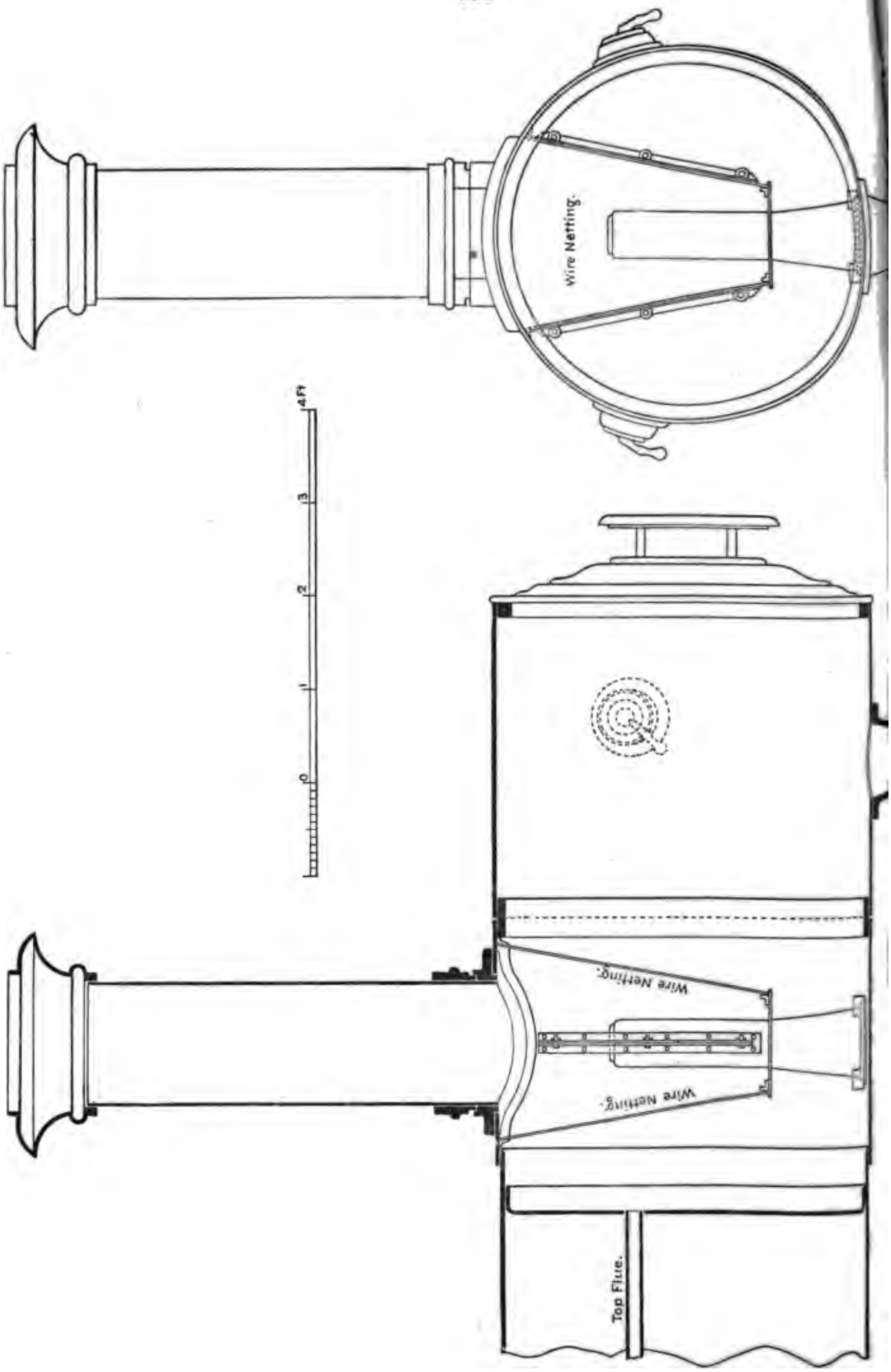
THE PRESIDENT—This question then is disposed of for the present. The next report is that of the Committee on extended smoke-boxes. The Secretary will now read it.

IS THE EXTENSION OF THE SMOKE-BOX IN LOCOMOTIVE ENGINES BENEFICIAL? IF SO, TO WHAT EXTENT?

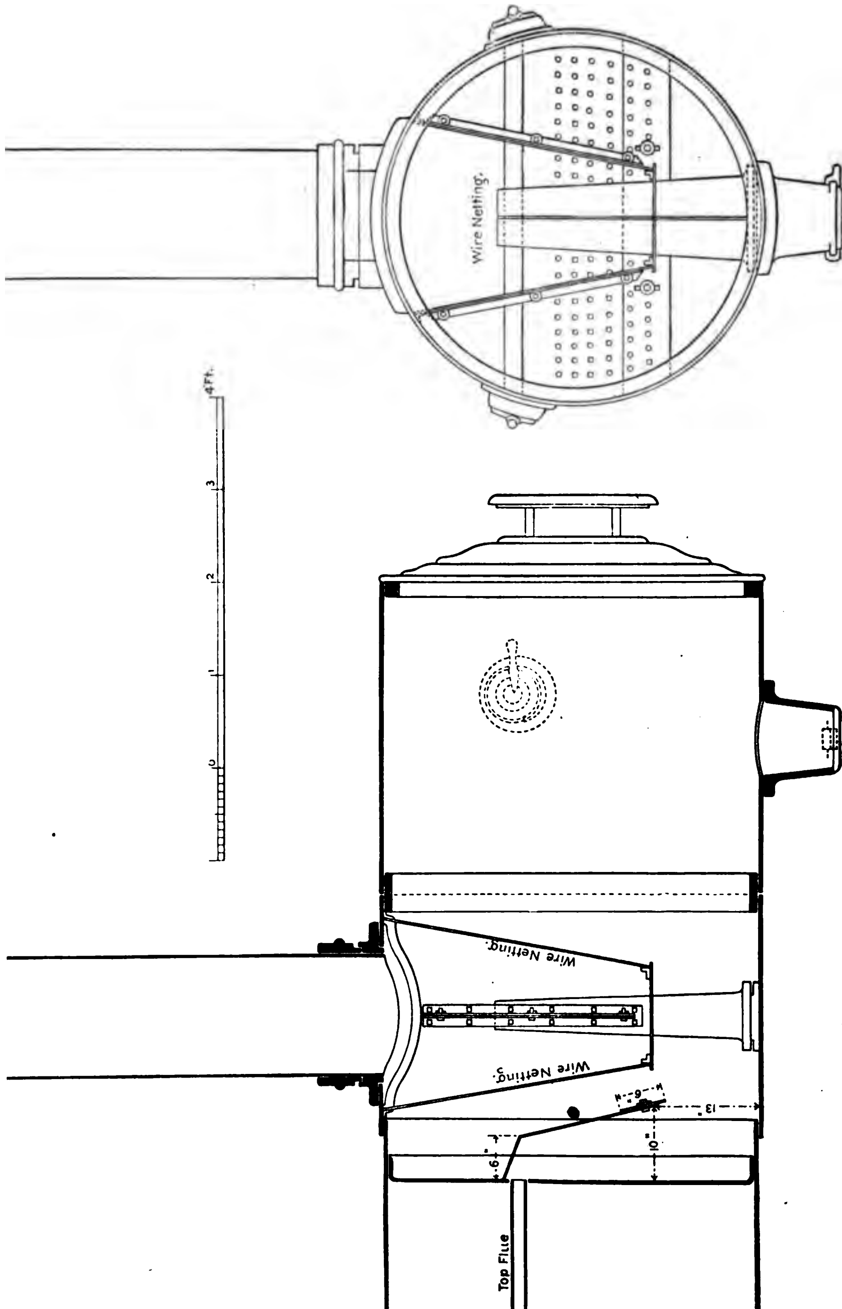
To the American Railway Master Mechanics' Association:

GENTLEMEN—In reporting upon the benefits derived from the use of the extended smoke-box, or spark arrester, I would most respectfully state that my two and a half years experience in its use, and the expressed opinion of several master mechanics, my seniors in experience, find the extended smoke-box beneficial to this extent, namely, economy in fuel, cones, netting, smoke-stacks, etc.; also more free and regular steaming qualities, insuring against fires, and guaranteeing cleanlines to both train and engine. I now have twenty-one locomotives equipped with the extended smoke-box or spark arrester, thirteen being in passenger, and eight in freight and switching service. During the past two and a half years that it has been in use, no fires have been reported on the line of road, and blame attached to any engine equipped with the extended smoke-box. We have a much cleaner and pleasanter train, as most of the sparks are deposited in the extended smoke-box, and not hammered back over train to annoy passengers, injuring newly painted or varnished coaches, etc. As a rule, a train consisting of from four to six ordinary coaches, and a fair quality of coal, such as is used upon Western roads, the locomotive will deposit from forty to fifty bushels of sparks into the extended smoke-box in 100 miles run. This of itself is appreciated by the passengers, and quite an advertisement for the road. In point of economy there is a saving in fuel, but to what extent I am unable to state, but certainly since we can use from ¼ to ½ inch larger exhaust openings, thereby gaining a better steaming engine, and consequently a saving in fuel. Mr. James Meehan, General Master Mechanic Cincinnati, New Orleans & Texas Pacific Railway, claims a 20 per cent. saving in fuel compared to the old diamond stack and lift pipe. Mr. Meehan, in connection with the extended smoke-box, also uses the brick arch in fire-box. I find quite a saving in netting, cones, smoke stacks, etc., as these several parts used with the extended smoke-box will last about as long as any other part of the box or boiler, there being no hammering of sparks to wear them out. We, of course, have a more free working engine, owing to the large exhaust openings. This is accomplished

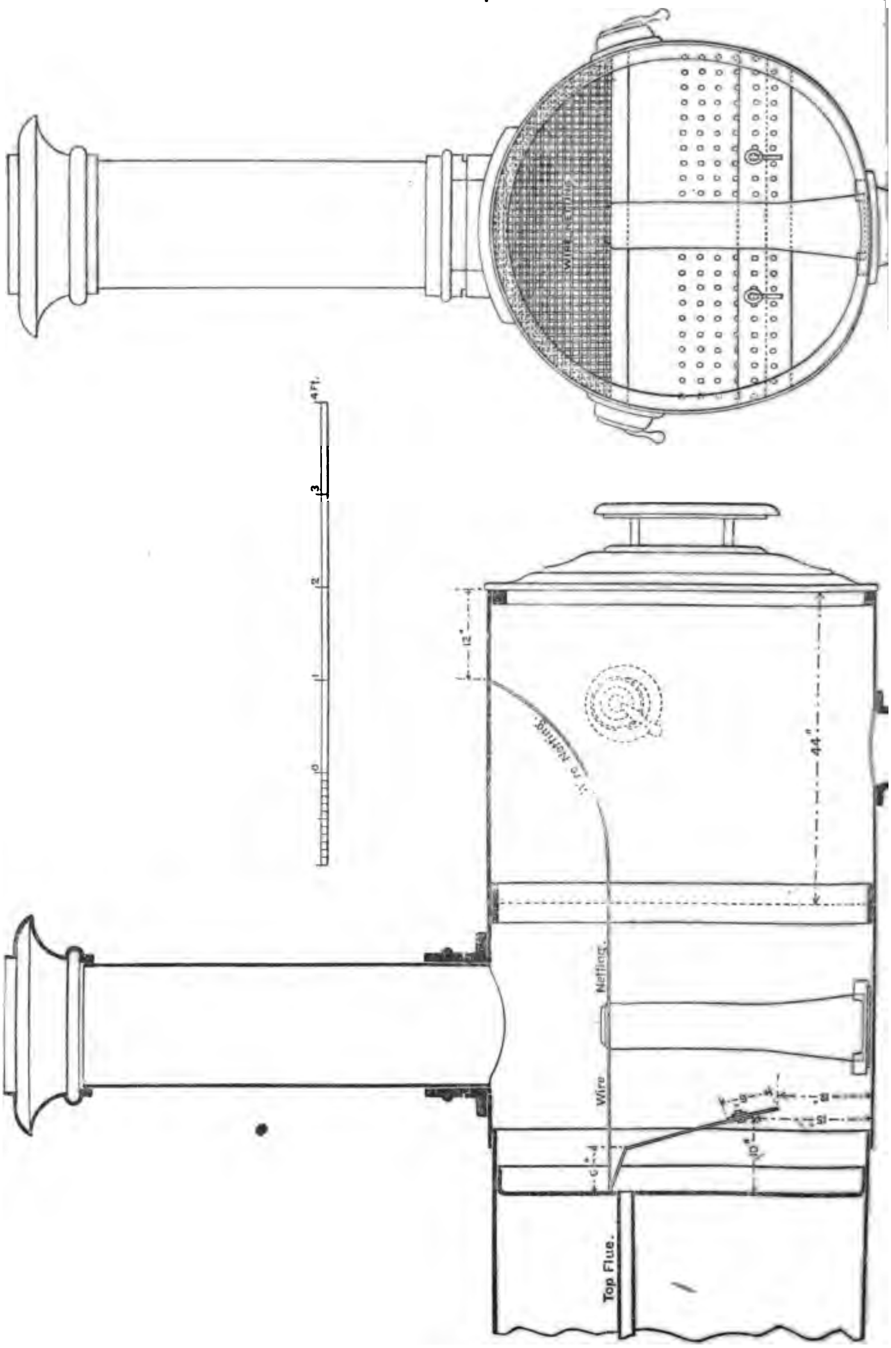
by using the high exhaust pipes and diaphragm plate, which reverse the draught upon the fire through the top flues first, instead of the bottom, therefore we obtain a more general and uniform draught upon the fire, and the benefit of all the flues in the boiler, which is impossible with the low exhaust and lift pipe, as a number of the lower or bottom flues are, as a rule, stopped up by cinders, etc.; also a number on each side of the boiler had just as well be, for all the advantage that is derived from them is but of slight benefit to the steaming of the engine. In my opinion there is no question as to the merits of the extended smoke-box, straight stack, high exhaust and diaphragm plate, but it is like all other parts of the engine—if the work is not properly done the engine will not do well. I am very sure that roads that have tried the extended smoke-box, and pronounced it a failure, had it applied to their boilers in an improper manner. It is highly important that both the smoke and extended arches be as near air-tight as it is possible to make them ; in fact, should be as air-tight as the boiler is steam-tight. If attention is paid to their construction, and the work properly executed, they cannot fail to be a success and improvement over the old diamond stack, cone and netting. I here give prints showing three plans of arranging the netting, spark-pipes, diaphragm plate, etc., all of which I have experimented with. Print marked "Extended Front, adopted by Cincinnati, Indianapolis, St. Louis & Chicago Railway," is the arrangement I have adopted for general use, as I find it to work the best. I find the diaphragm plate indispensable with the high exhaust. In cutting down the exhaust below the top row of flues, and dispensing with the diaphragm plate by using a perforated spark-pipe, as shown in one of the prints, I experienced considerable trouble in throwing the sparks far enough forward in the extended smoke-box, consequently the sparks accumulated too near the bottom flues, and around the bottom of the steam-pipes, but with the diaphragm plate and high exhaust, they are thrown well forward and out of the way. Mr. Meehan, General Master Mechanic Cincinnati, New Orleans & Texas Pacific Railway, informs me that his Company paid in last year for fires on their Lexington Division $30,000 when using the old diamond stack, and on same Division this year, by using the extended smoke-box, there were no fires.



Style of Extension Front—Cincinnati, Indianapolis, St. Louis & Chicago Railroad.



Style of Extension Front—Cincinnati, Indianapolis, St. Louis & Chicago Railroad.



Style of Extension Front—C., N. O. & T. P. Rwy.

I annex a statement from Mr. Meehan, showing saving in fuel of different engines on the Cincinnati, New Orleans & Texas Pacific Railway, by the use of the extended smoke-box and brick-arch in fire-box as against the old diamond stack.

Respectfully yours, J. S. PATTERSON.

STATEMENT,

Showing saving in fuel effected on engines on Cincinnati, New Orleans & Texas Pacific Railway, equipped with the extended smoke-boxes.

Without Extended Smoke-box, 1882.						With Extended Smoke-box, 1883.					
No. of Engine.	Size of Cylinders.	Mileage.	Service.	Coal Consumed.	Pounds per Mile.	No. of Engine.	Mileage.	Service.	Coal Consumed.	Pounds per Mile.	Saving in favor of the Extended Smoke-box.
9	16x24	5,192	Passeng'r	2,860	44	9	4,430	Passeng'r	1,860	34	10
45	17x24	5,032	"	4,020	64	45	4,756	"	2,625	44	20
38	18x24	2,018	Freight.	2,465	98	38	2,492	Freight.	2,050	66	32
17	17x24	2,649	"	2,982	90	17	2,291	"	1,825	64	26
21	17x24	2,370	"	2,800	95	21	2,418	"	1,625	54	41
27	17x24	5,143	Passeng'r	4,345	68	27	5,310	Passeng'r	3,175	48	20
43	18x24	2,858	Freight.	3,045	85	43	2,485	Freight.	2,075	67	18
46	17x24	4,740	Passeng'r	4,282	72	46	4,756	Passeng'r	2,875	48	24

The Secretary read the report.

The Secretary read a letter inviting the members of the Association to be present at a parade to be given in honor of the old locomotives at the Exposition of Railway Appliances, at 7 o'clock that afternoon.

On motion of Mr. Setchel, the invitation was accepted.

Another letter was read inviting the members to witness the working of the Shaw locomotive. A member moved that the invitation be accepted, with the understanding that the President fix the time.

MR. SETCHEL—I think the proper way to do would be to appoint a committee to ascertain how many members would like to take a trip of that kind, and I move that a committee be appointed to ascertain the members who would like to go, and report to Mr. Lockwood at the earliest possible time.

The last motion was put and agreed to. Messrs. Place, Johann and Lauder were appointed as the committee.

On motion of Mr. Lauder, the Convention then adjourned until the following day.

THIRD DAY'S PROCEEDINGS.

The President called the convention to order at 9:30.

THE PRESIDENT—Gentlemen, we have with us this evening, by invitation, Dr. B. Joy Jeffries, of Boston, who will now address you on the subject of color-blindness.

DEFECTIVE VISION AMONG RAILROAD EMPLOYES.

BY DR. B. JOY JEFFRIES, BOSTON, MASS.

Mr. President and Gentlemen of the Association:

In responding to your invitation to address you on "Defective Vision among Railroad Employes," I have, for the second time, traveled one thousand miles from home and left my professional work, in my continued labor in behalf of a control which shall be protective to the community and just and fair to all those immediately concerned. The action of State Legislatures, and of the railroads themselves, so entirely prove the necessity of the control I have advocated, that I need not consume your time or mine in arguing that before this association. My purpose will be to endeavor to explain in a simple and practical manner the defects of form and color perception as affecting railroad employes in performance of their duties, and to show you the means and methods used in detecting such defects. The necessity of tests and examinations being made by those who are alone competent to carry them out will thus be apparent, as well as the need of the establishment of definite standards of requirements for the several classes of employes.

As a cause very largely depends upon the personal character of its advocates, I am here compelled to again publicly assert that all my labor for the control of defective vision on land and sea has been done without remuneration or reward from any source whatever, and is, on the contrary, a heavy drain on my purse, only replenished by professional labors. This association must recognize this.

Our eyes have two functions or senses, both of which have to be used by the railroad employe. These two are the sense of form and the sense of color, quite distinct from each other, as either may

be present alone. A man so blind from cataract as to be only able to say where the window is will yet distinguish quite fine shades of color: On the other hand a person wholly blind to color may have extreme acuity of vision for form, able to see at great distances. Ignorance or a lack of recognition of this difference between the form and the color sense have caused railroad officials to make curious mistakes in giving their opinions about the control of defective vision among employes. Letters which some of them wrote to the counsel of the employes at the recent hearing before the Railroad Committee of the Massachusetts Legislature were really laughable, were the subject not too serious a matter.

I, therefore, must explain practically these two senses, and show you also how their imperfections bear upon railroad work. From the diagram of the human eye, which simply represents a camera, you see that the front part of the eye, the lens and the transparent curved portion, must be quite transparent and clear, in order to give us a perfect picture on the retina—in other words, distinct vision for form. On the other hand when the front portion of the eye is removed, we shall, as you see by the diagram, have the colored light reaching the retina, and this color we perceive, as we could even perceive it through ground glass or in a fog. Hence the great value of colored signals, especially at night. Form signals exclusively could be used by day, though color even then is an advantage, but for night we must use color. I am constantly asked by those not familiar with railroad work why form signals could not be substituted for color at night. I need not stop to show why they cannot, to members of this association. I refer inquiries to my manual on color-blindness and my various publications.

There are some points concerning the sense of form which have been much misunderstood, and naturally very falsely stated by those interested in exciting, for personal or political purposes, railroad employes against their employers, etc.

Normal vision is the power of sight for form which the average eye of mankind has. It is determined by simply trying the sight of hundreds of thousands of people and getting the average power. These rows of letters decreasing in size from the top to the bottom are our *test letters*. The distance at which the *average* eye can see

each row is marked against it. A person at 20 feet will see the row of letters marked XX. If they can read the letters below these their sight is better than the average; if only these above, then not so good. Now this standard for normal vision is really a low one. I have found that about eighteen or nineteen out of twenty among railroad employes have vision far better than this average or normal. The other one or two out of twenty are apt to have very poor sight, quite unfitting them for railroad work, where it really seems as if many purblind mechanics gradually drifted. My practical experience has been that railroad officials when they saw the amount of vision certain employes had whom they brought to me to be tested, removed to other employment these very men, though their vision came up to the standard asked for by experts and required by the regulations proposed by them, contained in the pamphlets I have placed on the table for distribution among the members. When the community understand the matter—and they are rapidly learning about it, since they are all interested—they will demand a higher standard of visual power than we experts now ask for.

Now any of you with these test letters can find out the power of sight of your employe, provided he has not learned them by heart, has not an accomplice to help him out, or telegraph him his answers, etc. But suppose his vision falls so far below the normal that you are afraid to trust him? By approaching he reads the letters, and seems, therefore, near-sighted. By what standard will you decide on his case? Naturally you turn to the *seemingly* practical test of trying him with the signals on your road. Here, however, you are quite confused. At one time he seems to tell you rightly (even without guessing, which is hard to exclude), at another quite wrongly. The cause of this I will explain, and you will readily see why a professional man competent to examine the eye within and without must make the test.

Now near-sightedness you naturally understand in a general way, and that it is relieved by properly-selected concave glasses. It is, as seen by the diagrams, caused by the eyeball being too long or egg-shaped, and is corrected by the concave glass. There is, however, a natural condition or shape of the eyeball exactly the reverse of this. The globe is too flat, as the diagram shows, and a *convex*

glass must be placed before it for the person to *see clearly in the distance.* That is, the eye must have glasses all the time; quite impossible, I think you will admit, for engineers and firemen at least. Children with such eyes may need glasses as strong as their parents or grandparents wear, as soon as they commence school life. In proportion as they are less over-sighted, as we call it, will it be later in life that the necessity for glasses comes for seeing in the distance. You know that a man with natural eyes begins to need convex glasses to read with at from 45 to 50 years of age, whilst his sight for distance keeps the same. The over-sighted man needs convex glasses for distance also. The less the amount of his defect the longer will he be able in life to make up the difference by the muscular effort in the eye which changes its focus, as the diagram shows. The muscle in the eye is like the other muscles of the body. By excessive use it gets tired, as do our legs and arms. An over-sighted man at whatever time of life his muscles fail him, will naturally manage to see pretty well when he is rested. Hence at such time he will seem to you to see quite well enough, but after his day's work, or as soon as his eyes are tired, they cannot focus, and his sight is blurred. It would not be blurred with properly-selected glasses, which, however, only certain classes of employes should wear. Hence in the proposed regulation a person is to be rejected for some railroad work if over-sighted beyond a definite given amount, because they will sooner or later be unable to see distinctly at a *distance* without glasses. The determining the existence of this condition of the eyes is a matter which only experts can do. It would be wholly unfair to the employe to let any one else attempt to decide upon it. I mean, moreover, that the expert should be entirely governed in his decision of rejection or acceptance by legally constituted standards. Cases of over-sightedness have been referred to me that had puzzled the official. The employes had met with repeated accident, yet their vision when tried by the official under the circumstances I spoke of—namely, *with rested eyes*—seemed good enough. The latter was made to understand the condition when finding his employe was helped by convex glasses for distance, which glasses entirely blurred the official's normal eyes. Of course railroad officials, as you members and the community at large, understand near-sightedness in a general way; but this other

condition, perhaps quite as common, and apparently so curiously hiding itself, is not recognized or understood. All employes whose work allows them to wear glasses should do so if their eyesight is improved thereby. A new man should not, however, be accepted for a position which his eyesight will prevent his properly filling when he gets on in life, when his experience and knowledge would render him valuable were his sight not failing him for distance, and only to be restored by wearing glasses. Hence young men desiring to become firemen and engineers should be carefully tested by a competent physician as to the possible existence of this over-sightedness, which I have tried to explain. No official or any of the laity can decide this. It will be hard on a man to be thrown aside at 45 or 50, from sight failing for *distance*, only to be relieved by glasses which he cannot be allowed to wear. A proper test of his vision when he was to enter service would have shown that this failure must certainly come, and the discovery would have prevented his acceptance, and very probably caused the young man himself to turn aside to a position or work he could follow out successfully. This trouble, we must remember, is not a disease, or caused by any disease of the eye. It is due to the natural shape of the eyeball. The globe is a *little too short*, whilst near-sightedness is caused by its being a little too long. I have dwelt on this point, as it is such an important one, quite misunderstood, and one that bears so directly on the efficiency of an employe, whilst justice to him and to the community can only be obtained by an examination such as an expert alone can make. Hence the need of the latter.

Of course it would be very easy, as I said, for any railroad official to simply ascertain a person's visual power by these test letters. But suppose an old and very competent engineer does not come up to the normal, or a younger one seems to fail to do what he had by previous record of testing. It makes all the difference in the world, as to the safety of retaining them, what the cause is. If commencing cataract in the older man, which an expert alone can determine, then he must be at once placed at some other work. If it is a local, only temporary, trouble with the younger one, which an ophthalmic surgeon alone can decide, then he need not lose his position. The regulations proposed by the experts who have tested

thousands of employes are, as you will see, particularly lenient to employes of long standing and good record. I have always been guided by these, as no standards are set by law in my State.

As to the natural change of the normal eye with advancing age, I mean the need of glasses at from 45 to 50 years. This does not affect the employe's distant vision. Whatever his position he should always have by him the glasses he needs to read an order or a telegram. He will save money and his eyes by having these selected and prescribed by the company's medical expert There is still another defect of the eye in respect to form perception, which will readily conceal itself from other than the expert examiner, and it bears directly and curiously on railroad work. It is this: The human eye may be near or far-sighted in only one, for instance, the *horizontal* or *vertical* meridian. The defect is corrected by concave or convex glasses which affect the focus in one meridian alone, namely cylindrical lenses. The defect is called astigmatism. The person affected sees, for instance, vertical lines or bars very well, but horizontal ones are blurred and indistinct. A patient of mine could not see a distant clock at quarter past nine or at three, whilst at six and half-past twelve he read the time easily. Properly selected cylindrical glasses cured the supposed trouble in his head, which came on every morning after reading his letters, viz., *quarter past nine.* Whilst I think of his case I remember that he was also quite color-blind, and painted a pea-green lion for his little boy. Another patient, a sea captain, had to turn his head over sideways to read the compass when in a certain position. You will see, therefore, that an employe who had this defect might well escape any ordinary examination, yet all signals which must be seen in a horizontal position may be quite blurred to him, whilst when vertical he could read them. The trouble is quite a common one and a source of great annoyance to its possessor, often, if not corrected by proper glasses, a positive hindrance to any employment requiring good eyesight. I think all the members of the Association will now practically recognize the fact that the determining the visual power, that is, the employe's eyesight, is not a simple matter, and one for an expert to do.

Before turning to color-blindness, I must explain some points as to the normal senses of form and color which are very practical, yet

quite ignored or misunderstood. Our sense of form, as also that of color, is best directly in the centre of the retina, and over a very small space bad. You will all remember how carefully you have to fix your eyes to see the best. Now if you close one eye, and look with the other at the word constitution, for an instance, in a printed page, there will be only three or four letters that are plain, and you have to run your eye along to see the whole word. This, by the many and strong muscles moving the eyeball, we do so rapidly and easily that we are really unconscious of the fact. The same holds true of the sense of color. With one eye closed look at, say, a colored wafer with the other, and then, keeping the eye fixed, carry the wafer to one side, in any direction, and you will be surprised to find how quickly its *color* is lost, whilst we can still see its shape. Of course, when the image in the eye falls on the optic nerve entrance we do not see it at all, that being our "blind spot," as it is called. This is not what I refer to. A signal whose image falls on the retina to one side, away from the centre, will be perhaps missed or misunderstood. This may well occur with the rapid motion of a train, especially as the engineer naturally keeps his eye fixed on the track ahead.

Again, another point which is both curious and practical I can readily show you. When we awake in the morning, and the eyes are rested, and the retinæ quite sensitive, if we look steadily for a few seconds, say, at a picture on the wall with a dark frame, and then turn the eyes to any other part of the room, the picture will seem to hang wherever we direct our sight. It is simply because the impression on the retina is only gradually effaced, just as the sensation of a prick of the skin gradually passes off. Wherever we turn our eyes we shall see the picture, but the frame will be *light*, not dark. All light parts of the picture will be dark, and the dark light. This is called the complementary after-image. White spots on a black target would thus appear as black on a white target.

Now this same is true of the sense of color. The after-image, which is mental, and which we cannot suppress, will assume the complementary color. This is readily proved to you. Look steadily at the black cross in the centre of this red disk I hold up before the white sheet of paper, whilst I count twenty slowly. Now when I

remove the red disk, look at the black cross on the white paper, and your eyes must see a *green disk*, not so strong in color as the red, yet very distinct. Green is the complementary color of red. When now I do the same with this *green disk*, your after-image is a pale red. This is a physiological law of all normal eyes, and has nothing to do with color-blindness. Its practical bearing, however, you will readily understand. An engineer sees a red light ahead and watches it steadily, as it is danger. The light disappears from any cause, and as he still looks ahead he sees a green—*safety*.

The three primary colors are red, green and violet or blue. All other colors are from a mixture of these three. I do not refer to the mixture of pigments, which is quite another thing. Now two of these colors, *red* and *green*, are used on railroads for danger and safety, etc. Blue cannot be used, because if we tint a glass sufficiently blue to be distinctive, the light will not pass through it. Hence, as you well know, blue lanterns can only be used where they need be recognized close to.

Now another natural condition of the *normal* color sense is, that at the centre of the retina, in a small circle, we can distinguish all three colors, red, green and violet. In a ring or zone next outside of this we lose the sensation of red and perceive only green and violet; and again in a zone outside of this including the rest of the expanse of the retina we fail to perceive any color but violet or blue. So that practically certain portions of the normal retina are color-blind. To perceive a color well, we instinctively fix our eyes so as to bring it on the centre of the retina, where we can best see it. These conditions hold true under any ordinary illumination which we have in day or artificial light.

COLOR-BLINDNESS AFFECTING RAILROAD WORK.

I have shown you the superiority of color over form for signals to attract the eye. Any loss of the sense of color, therefore, becomes a serious matter for railroad employes. You instantly ask me, "What is this color-blindness?" To answer you scientifically would be by no means an easy matter; but I *can* answer your question practically. As I said, there are three primary colors, *red*, *green* and *violet*. Now color-blindness is failing to see one or more of these. A person may be wholly color-blind and see only light

and shade in nature. This defect is extremely rare. The next rarest is violet-blindness, which would include blindness to its complementary color, viz., yellow. Now red and green are complementary colors. A person blind to one is blind also to the other. Hence, by the term color-blindness, as now used, we mean inability in a greater or less degree to see these two colors, just the two of the three primary which must be seen on the water and in railroad work by those giving or reading signals. Such people see blue and yellow about the same as the normal-eyed. But red and green, and all colors in which these are *components*, are to them so much *gray*. You can exactly simulate to their eyes what is red or green to us by mixing black and white in proper proportions, according to the amount of their defect. A white lantern *when smoky* will seem to them exactly like a green or a red one. In other words they must *guess* at the color of a light from its brightness. The danger of this you can readily appreciate. I would refer you to the interesting report of the case of a Swiss locomotive engineer in my manual on color-blindness, which brings out this point most clearly.

In classifying the color-blind, experts speak of them as *red* or *green*-blind; others use the term red-green-blind. From this people have jumped at the conclusion that the *green*-blind could see *red*, and the reverse, viz., the *red*-blind see *green*, and hence a green-blind was perfectly safe on a road where red alone was used. Such ignorance is, of course, utterly inexcusable in those whose duty it is to examine and study this subject as an important part of their official duty.

The danger from color-blindness is naturally dependent on its frequency and the difficulty of detecting it. Now, thirty years ago in England its present well-known frequency was insisted upon and the attention of railroad corporations called to its danger. Principally from the lack of a certain and rapid method of detecting it the whole subject lay in abeyance till Prof. Holmgren, of Sweden, stimulated by a very serious railroad accident there, applied his scientific knowledge and study, which had been especially directed to the color sense, to the invention of a ready means of testing large numbers quickly and accurately. We ophthalmic surgeons had long been familiar with this loss of the color sense associated with certain diseases of the eye and brain, but the means of detecting this loss, or even the congenital defect, were too cumbersome and required

too much time for us to propose any control on land or sea, since it would be at once rejected. Early in 1877, as soon as *practically* familiar with my friend Prof. Holmgren's method, I earnestly publicly advocated the necessity of expert examinations and laws of control. Such expert examinations and such laws could then, and could now, be applied so easily and so *cheaply* that there is no longer any excuse for its not being done on every railroad in our country.

As I have said, the quickest and surest method of testing for color-blindness is that of Prof. Holmgren, which I will now exhibit and describe. By it already some hundreds of thousands of people of both sexes, and all ages, and countries, and races and colors have been examined. I myself have tested 19,229 males, among whom I have found 803 color-blind. I have also tested 14,925 females, and found only 12 color-blind. My results with males are the same as those of all examiners who have tested large numbers, viz., that about 4 per cent. are color-blind. I have found very few color-blind females. Others report about one-fourth of 1 per cent. as defective. I hasten to say that this exemption has nothing to do with their greater familiarity with colors from childhood up. It is simply a sexual difference. Their familiarity with colors only allows them to go through with test more rapidly. Those of them born color-blind die so.

I must refer you to my manual for special description of the peculiarities of color-blindness, and can here only briefly sketch them. It is a *congenital* defect. It is *hereditary* and follows the general law of heredity. It is handed down from parent to grand-child, and thus through the female sex, though they escape as I have said. A color-blind man, for instance, has five children—three sons and two daughters. None will be color-blind, but the daughters' boys will be in the next generation. As if to only prove the rule, a peculiar exception has once been noticed, where only the girls were color-blind for several generations.

It may occur in one eye only when congenital. This is very rare; but in all examinations each eye should be tested separately, for the subsequent loss of the normal one may occur.

It is a curious fact that certain color-blind who could be put in the so-called hypnotic condition could, whilst so, see colors, and

those who are normal-eyed when hypnotized became color-blind temporarily. This is, of course, but a scientific curiosity.

Color-blindness is *incurable*. A man born so dies so. Nothing can change his color-sense. No education, or experience, or familiarity can alter it. He may *seem* to have altered it, but we now readily understand that this is a mistake from incomplete observation, etc. My manual tells the whole story about this.

Color-blindness can only be *slightly palliated*. It was long ago noticed that those defective did not make such gross mistakes by artificial light. So also if we let them look through a piece of pale lemon-colored glass, that quite resembles artificial light, they will seem to be helped. It is, however, but seem. A color-blind scientist in Belgium found he was helped by looking through a solution of fuchsine, one of the red aniline dyes, and he even thought he was to be cured by this. So far did this go that it was gravely proposed to attach an apparatus to the engines, consisting of two glass plates and this solution between them, for the driver to look through to help him in case of being color-blind. Of course the whole thing proved a delusion, as did the idea of being cured by it.

Injuries of certain character, and particularly the shake-up or shocks from railroad accidents, may cause a person to lose his sense of color, or greatly impair it. Hence the regulations proposed require an employe to be re-tested after any such accident before he goes to work, and this is the only need of *re*-testing for color-blindness. Testing once in two years, as was in the Massachusetts laws, or once a year, as advised by the Massachusetts Railroad Commissmissioners, is, of course, nonsense, which I have always argued against. As you now know, the first has been repealed at my instance, biennial examinations having been stricken out of the law, which in other respects remains the same.

Disease also of the brain, or possibly of the eye alone, causes a condition of color-blindness, interesting cases of which among railroad employes have been reported. Again I would refer you to my manual. Certainly after any serious disease, as fever, etc., an employe's form and color sense should be tested before he returns to duty.

Alcohol poisoning produces a condition of color-blindness. Not, of course, but what thousands of people abuse alcohol without losing

their color sense, yet chronic alcoholic poisoning *does* affect the chromatic sense, whilst perhaps not affecting the sense of form, or the visual power sufficiently to prevent the man going on with his work and escaping detection.

Tobacco poisoning has a similar effect. You well know that thousands use tobacco most inordinately without visible effect. But the physician sees cases of direct loss of sight and color from tobacco poisoning in people perfectly temperate as to alcohol. When *both* alcohol and tobacco are abused, their poisonous effects may be dangerous to others than the victim himself. Hard drinkers and heavy smokers should be looked after as they get on in life. Color-blindness may occur among those whom these two intoxicants have never caused the loss of a day's work. To ophthalmic surgeons, of course, all this is very plain and of every-day notice. Your attention I would simply call to it, as it may help explain the mistakes or the accidents caused by your employes, however trusted and trustworthy they may have been.

COLOR-BLINDNESS DIFFICULT TO DETECT.

The seeming facility with which experts now detect color-blindness by the present methods of examination has led to the idea that it was a very easy and simple thing to do. Moreover, all those unacquainted with the subject imagine that testing is done by asking a person to *name colors*. But years ago scientists had shown that asking names of colors was simply ridiculous as any means of deciding whether an individual saw colors as we do. We now also know that such a method would be totally unjust to railroad employes, since they, as the rest of the male community, have had little if any color teaching. All examiners, in all parts of the world, have found this heretofore unrecognized ignorance on the part of us males as to distinguishing colors and giving their names. Experts have also repeatedly shown and said that the really dangerous color-blind will escape detection if we attempt to decide on their chromatic sense by asking them to *name* colors. They may even *appear* better than others of their class with normal color sense. This fact is now so generally admitted that I need hardly occupy your time in further discussing it.

This apparent naming of colors correctly by the color-blind has been one of the many means of their defect having been heretofore

concealed in every-day life. I must refer you to my manual as to the various ways they escape, and the curious manner in which, often wholly unconsciously, they supplement their defect. These means seem ridiculously simple now that we understand them. Of course had we formerly known of the extent of color-blindness—I mean had there been a general knowledge of it—individual cases would not have escaped. Now they are detected frequently in every-day life from the more general knowledge which I have tried to spread abroad in the community.

Now not only have the color-blind escaped detection, but when experts have found them out railroad officials and commissioners have failed to be convinced of the defect or its danger, often simply because they asked them to *name* the lights, when even guessing might serve as well as seeing. There are, however, some other causes which help to confuse the laity in attempting to decide. One of these is the fact, which they have not understood, that the color sense, like the form sense, decreases with distance. We see a signal of a certain size within a certain range, and just so we cannot see a color beyond a certain range. This is true of the normal eye, but still more of the color-blind eye. A man, for instance, somewhat defective, under good surrounding circumstances, may fairly make out a red lantern at 300 feet, when at twice or thrice that distance the color would be gone for him. This especially if he was not wholly color-blind. The absurdity of deciding on a man's fitness by testing him with lanterns, etc., held up across a room, or the length of a station, even when the names of the colors are not asked, is now too apparent, and already well understood by some officials who have tried to test.

Another way the laity have been deceived in endeavoring to confirm or deny the expert tests has been from the color of the glasses used. When I argued at Washington before the Board of Supervising Inspectors of Steam Vessels against the local inspectors being allowed to test pilots with the colored lanterns used, I showed them these two glasses, both used for *green*, on the starboard side of a vessel. One you see is almost a blue, quite dark, and would transmit but little light, as we now well understand; the other is a very pale, yellowish green, which would in the slightest mist or fog quite resemble a *white* light as we call the really quite yellow-

ish light from all artificial illumination, except the electric. Now the board had to confess that these lights were perfectly legal. In consequence they asked to have *standard* red and green lights put in the hands of the local inspectors. But this was easier voted than done. I persuaded finally the New England Glass Works, of Boston, to attempt to make red and green which would meet the requirement and stand scientific tests. That they at last did, and I show you the result in this beautiful red and very distinctive green which have been adopted by the Treasury Department for steam vessels. I must add in passing that I have no pecuniary interest whatever in this glass or these glass works.

Now as to red and green glass on railroads: We have no laws requiring any standard, and you all well know how the glass varies. These switch lights which I hold up are, as you see, quite as bad as the marine glasses. You notice the contrast between them and these other switch lights of the standard red and green which I hold up beside them. The tendency, of course, among all glass-makers will be toward such colors, and the nearer they come to them the worse for the 3 or 4 per cent. color-blind, and the better for the other 96 or 97 per cent. of employes with normal vision.

Now the local inspectors with the bluish and yellowish-green glasses used, and in the same way railway officials and commissioners, etc., with similar glasses on the roads, could not detect color-blindness, and readily and quickly assumed *what they naturally perhaps wanted to*, viz., that the experts were wrong, and that there was no danger from color-blindness. The reason I think you will now easily understand. The color-blind, that is the people who see red and green only as *gray*, can see *yellow* and *blue* as we do. They would, therefore, make out such glasses quite well and always call them green, because we do. Anything different shown them at the same time they would call *red*, which it would be, of course. In all which there would be no proof that they could see a *red* danger signal correctly, and the expert, *were he appealed to*, could prove this at once, as has been repeatedly done. With the standard red and green glass local steamboat inspectors now always confirm the report of the examining surgeon. The laity and even officials seem moreover to forget this important point, viz., that it is not *distinguishing between two lights held up together*,

but the *instantaneous* recognition of either *alone* that is needed on both land and sea. The stronger the lights are as to brightness, which depends on the glass transmitting the light well, and the more separated and distinctive the colors, the quicker will the eye catch them, and the greater the safety.

HOW, THEN, SHALL WE DETECT COLOR-BLINDNESS?

We cannot rest our decision on what the person examined *says*. We can't trust his tongue, even when all the elements of guessing and connivance, etc., are really eliminated—very important practical factors. The only other way we can find out how a certain sensation affects another person's brain is to get them to make some muscular effort, to do something which shall betray them, so to speak. With colors we can do this by *comparison*. A muscular effort has to be made by the examined moving his hands and arms, which effort is wholly governed by the sensation the color produces on the brain. No better comparison test has been devised than that of Prof. Holmgren, the head of the government control in Sweden, known as the worsted test. In the hands of experts this has proved itself the quickest, surest and most thoroughly practical and reliable. Of course it will, as will still more many others, prove unreliable and unfair to the employes when attempted to be carried out by railroad commissioners or officials who have not studied the whole subject with experts and who cannot become experts from lack of the medical and special education needed as a basis for the study. A person, to be an examiner, whether he is a medical man or a specialist, or neither, must of course be thoroughly familiar with the normal color sense as well as with color-blindness, and know just how both comport themselves in reference to the perception of color. He must have practical knowledge of each and every phase of mistake which characterizes each kind and every degree of chromatic defect.

HOLMGREN'S WORSTED TEST.

After I introduced this test into this country in 1876, and especially since adopted with my manual by the Government, interested parties have steadily filled the public prints of the country with falsehoods in reference to it. To such an extent has this gone that a newspaper of this city (Chicago) seriously said "that the sugges-

ter of this whole movement, etc., ought to be put in prison, and the Government indicted by the oppressed color-blind pilot." The world and truth have certainly moved on, for in this very city I have really felt quite safe personally explaining this subject to the interested faces I see before me. Those of you, therefore, who have not seen expert testing with the worsteds, and who have, as is natural, read the newspapers and been induced from them and the general tone of remark among railroad men to think what has therein been stated to be more or less true, will scarcely believe me in my description of the test itself. Of course the office-seeker and the pettifoggying lawyer will never cease to have such articles as I speak of published so long as they can thereby excite your employes and get public mistaken sympathy for them, with the covert design of seeking their votes and the money they assess themselves for. My purpose is, by a simple explanation of the whole question, and especially of the test itself, to place you in position to refute these false statements to your employes, and disarm their opposition whilst exposing the chicanery and rascality of these office-seekers and lawyers who have thrown dust in their eyes and thus been able to pick their pockets of wages hard earned as we know these are.

Now here is the worsted test on the table before you. Some 150 little skeins of various colors, but very carefully and definitely chosen. The skeins are all about alike in size, and the three test-skeins are these larger ones—light green, pale purple and red. These must be very carefully chosen, as upon their color—of the first two at least—the success of the examination, and hence the detection of color-blindness, depends. I have, by request, arranged with Mr. N. D. Whitney, 129 Tremont street, Boston, to always have on hand, to be sent by mail on the receipt of $2.50, a complete set, and I constantly see that this type set is correct. To satisfy those who think or declare otherwise, I would here add that I have no pecuniary interest whatever in the sale of these worsteds, only desiring that those desiring to use Holmgren's method shall have the right material to properly carry the test out. On this latter account I must here state that the sets of worsteds and other material I have seen as sold by Wood & Co., in New York, were simply ridiculous.

The way of carrying out the test is this: On a white cloth the skeins are to be loosely heaped, and this large light green—No. 1 test—placed a few feet off to one side. This color is taken, not because it resembles the signal color, but because it is the color in the spectrum at the point where the color-blind begin to lose any feeling of color, which loss continues along through the green and out over the red end of the spectrum. The expert then asks the examined to simply pick out the skeins which are like the test ones in color, lighter or darker, any of that color. *He does not use a single color name* or ask the employe to say the name of a single color. The latter need not speak a word. There need not be a mutual language. The expert can readily pantomime, or go through with the selection as you see me now do, in explanation. I tested the deaf and dumb without trouble in this way. We want, of course, to be in a well-lighted room, and all who can crowd around may be present It is better that those who are to be tested should see what is done, as thus, if normal-eyed they will work quicker, and if defective they will learn nothing that can assist them and prevent their exhibiting their defect. We cannot use this test or any one with reflected light in artificial illumination, except, perhaps, the electric. Now on this card I have hung those colors which the color-blind confound, or see as like the pale green test. They are, as you see, *grays*, *fawns*, *stone color*, *light* and *dark browns*, and even *pale* and *full clear reds*. The order indicates also in a certain way an increasing amount of the defect. The color-blind will also pick out some pale greens, since these naturally look like the test. But sooner or later, generally among the first half dozen, or the very first, he makes the characteristic mistake which the expert translates as meaning that he cannot see colors as we do, and we know that no power can make him, no experience or study, etc., can ever alter his color sense. The success of the color-blind heretofore in concealing their defect has here and there induced a belief that education, etc., would change or help it. This mistake is now perfectly understood. The belief is still constantly cropping out, only to expose the ignorance of those who indulge in it.

By these mistakes which I show you we have now got at the fact that the examined is color-blind. The second test will bring this out still more clearly, and moreover tell us the character of the

color-blindness, and roughly intimate to the *expert* its amount. This large skein is pale purple, a mixture of blue and red. The color-blind do not see the red in it, and select *as like it* either these *blues* or *indigoes*, or these *grays* and *greens* which you see hung upon the card in a line side of the test. This test decides for the expert whether they are *red* or *green* blind. But, as I have explained, one practically involves the other. Both are color-blind—that is, see reds and greens only as grays, etc., and hence are dangerous on railroads.

A still further test is the third, with *red*, the color of the railroad flags. As like this, the color-blind will select dirty *reds*, *browns* and *greens*, as you see in the row of these selections which I have hung upon the card in the line with the red test skein. This third test the expert does not need, but it serves a very valuable purpose in convincing officials and others interested, of the reality of the defect in the employe, just what this defect means, and why dangerous.

Now this is the whole of the test about which you have heard so much that is false and misleading. I have given it to you just as described in my manual, where by reading it any one could have seen that newspaper accounts were but malicious mischief on the part of those interested in preventing being done what this test does, viz., the discovery of the color-blind among the employes and the proving to their employers their danger. No test will be satisfactory which does this.

As you have seen, there is no "darkened room," no "asking the names of colors," no calling for any "shading" or "matching colors," or any "knowledge which only a milliner has." The employe need not know the name of a color, or have ever seen any. Even *red* and *green* may be designated as danger and safety. No doubt this seems extraordinary to many of you after what you have read and heard about the test, yet you could have satisfied yourself by simply reading the description in my manual, that what you read or heard were malicious falsehoods, emenating from those interested in exciting your employes against any and all control of defective sight.

Now, what does it mean if an employe makes the curious characteristic mistakes I have shown you, provided, of course, that

they are real and governed by the effect of the test-color on his brain? Simply this, that such employe cannot see the colored signals used on railroads at the distances he must, to insure safety. He may, when not quite color-blind, hesitatingly make them out at distances ranging according to the degree of his defect. I showed you how officials, from lack of expert knowledge, or the assistance of an expert, deceived themselves and others on this point. I desire to say, and repeat to you most emphatically, that wherever *proper expert examiners* have declared by this worsted test an employe to be color-blind and dangerous, the further testing of him by flags and lanterns under the conditions chosen by the railroad officials and the employes themselves, has always confirmed the decree. Hence the great value of a test that, in expert hands, generally detects what has remained hidden before, and which could formerly only have been ascertained uncertainly, by as many hours' testing instead of as many minutes.

If now this test is always confirmed by examining with flags and lanterns, why not let railroad officials use the latter and decide for themselves? Nothing seems more plausible or fair. Yet the question was twice brought up and argued before the legislative committee of Massachusetts with the concealed purpose of breaking down all legal control, and twice I appeared before the committee, and, in spite of every form of plausible opposition, clearly showed that testing for color-blindness by flag and lanterns was really no test at all, and no official would ever detect a case. The question is discussed in my manual, and has long been settled. Where tests are honestly conducted, and guessing and collusion positively excluded, and even competent experts employed in the necessary numbers, it becomes a matter of play between examiner and examined, consumes no end of time, and may result in *an injustice to the employe* which cannot possibly occur with the worsted test *properly applied.* With the worsted test, an expert can at once pick out the color-blind without loss of time to employer or employe. On the Boston & Lowell road I went in a car attached to the paymaster's, and tested the men as they awaited their turn, both for color and form perception. Not a minute of time was lost, and no delay of the paymaster's train required. To do it of course required both knowledge and experience. These are always

required to *fairly* carry out any test and detect *only* the color-blind. It would have needed as many days as it did hours had I been confined to flags and lanterns, which *seem* so natural and conclusive. It is now well understood that the attempts made to limit testing for color-blindness to flags and lanterns used on the roads is merely the plausible argument of lawyers hired by the employes to attempt to prevent all control, legal or otherwise, or politicians seeking the employe's votes with delusive promises, both of whom in every way are trying to excite your men, who from ignorance and misrepresentation are easily assessed by their committees and pledged to vote for their seeming friends.

Now this misrepresentation has gone so far in the community that those of us who are working for the interests of *all* concerned, and, as in my own case, trying to protect employes, especially those already in service, look with some apprehension to the time when the community shall be undeceived of their false sympathy, and, as is so natural, turn against the personnel of the roads by requiring more stringent laws than are now asked for, and as the Pennsylvania road has already carried out. You all well know the action of the community under such circumstances, stimulated as it might well be by accidents, that "required something to be done and somebody sacrificed, right or wrong."

The deceptive seeming simplicity of the test, as one sees it carried out by an expert, has done much to mislead those who are or should be interested into the idea that it was a very easy matter to apply it. The Massachusetts Railroad Commissioners refused my invitation to properly study the matter with me, and consequently were so deceived with the apparent simplicity of the worsted test, that they stated to the legislative committee that "any boy of 14 could make the examinations." This will naturally raise a smile at their expense, as it has done.

A committee of ophthalmic surgeons in London undertook the examination of a large number of people to ascertain the percentage of color-blindness only, with no resulting responsibility as to railroad employes, etc. As I had advised them, they found it no easy matter to decide. In their final report to the national society they say, as I quote in my book: "Your committee becomes more and more convinced that a competent examiner is not made in a

day or even a month, and that, even with large experience, much judgment and capacity are needful to interpret rightly the acts of the examined. This necessity is perhaps most strongly exhibited in the case of intelligent persons who are incompletely color-blind. Such persons, though they may have a much fuller appreciation of the difference between red and green, for example, than is normal, may, after accurate observation and comparison, separate the red skeins of wool from the green. When tested, however, at various distances with colored lights, these defects are strikingly apparent, and it becomes clear that they are totally unfitted for responsible posts in which rapid appreciation of color at a distance is required."

Such disinterested evidence as to the need of expert testing is of more value than all the assertions of those who refuse to learn, and are governed by "ignorance, prejudice or pecuniary considerations." The reason why I dwell on this point will be apparent before I have finished. The very highest practical authority we have, Prof. Donders, of Utrecht, declares from his experience that only ophthalmic surgeons should carry out the examinations. Sweden has now national laws as to the land and sea. Tests can there only be legally made by competent physicians, who have proved by examination their knowledge of the subject, and their ability to test properly, as well as their own freedom from color-blindness. As you will see from the account in my manual, when the examinations were first commenced in that country they were put in the hands of the officials, with ridiculous results, some finding none and others reporting 15 per cent. of employes color-blind. Then it was transferred to the railroad surgeons, who did not succeed much better, till finally they were all ordered to Upsala to learn the subject and the method personally from Prof. Holmgren. They have since been able to test properly. The surgeons connected with your roads can do so also after they have had opportunity to learn and some experince, the latter of which is readily obtained by their testing the scholars and others in the communities in which they live. I would especially refer you and them to this point as I present it in my manual. The surgeons of the army, navy and marine hospital service have been enabled to test after the study and investigation and practice they were ordered to undertake.

I have very constantly and persistently in arguing before boards and committees, as now before this association, shown shat we were not profiting by the mistakes made in Europe as to the persons to be entrusted with the examinations wholly in reference to the tests themselves, and quite aside from the many other questions surrounding the subject, which have played so large a part in the difficulties encountered by endeavors to introduce a proper control in this country.

VARIOUS OTHER TESTS FOR COLOR-BLINDNESS.

Since the introduction by Prof. Holmgren of his worsted test, various attempts have been made to utilize the idea, but none of them compare with his method, which still remains the ideal one. The various ways of using the worsted method you see before you in the apparatus I have brought for your inspection from my exhibit in the Railway Exposition. There is still another, devised by my friend Dr. Thomson, the expert of the Pennsylvania road, and adopted, as many of you know, in the regulations governing the examinations of the employés for defective vision and hearing by that corporation.

I must show you in passing another *comparison test*, namely, that of Dr. Stilling, with printed colored letters. On a surface of one color in spots or blotches of another are roughly outlined letters or numbers or figures. The two colors are arranged to match those which to the color-blind look alike. Hence they cannot see or read the letters, figures, etc. I only mentioned it because it has been praised by those who had not *practical* experience with it; such experience will quickly convince any examiner of the infinite superiority of Holmgren's worsted test.

There are, as you see, amongst my apparatus various other *control* methods of testing. These are described in my manual. I will not detain you in explaining them, as they are only what experts would use in further investigation of a doubtful case referred to them, etc. We also require apparatus to prove that color-blindness does *not* exist, when it is feigned for any purpose, as it may be.

COLOR-BLINDNESS VARIES IN DEGREE.

It would be unfair to call for the same degree of visual power in all employes that we must require in engineers and firemen. In

many positions also men can wear glasses if they need them. We therefore measure the form-perception, judging from an average standard as I have explained to you. The color-sense varies in amount also. There are all degrees of color-blindness. Now just as for visual power, we ask only the average amount (which is a low standard, four out of five employes having much better); so as to the color sense, only the normal is to be required, and that only of engineers and firemen. Even less, the regulations proposed would require in those who have been long in service. These regulations ask, as you will see, for quite varying degrees of the color sense among the several classes of employes. Therefore the medical examiners must possess, and thoroughly understand, the use of apparatus for measuring the *amount of the color sense when it is not normal.* There are various methods in the apparatus I have here from the Exposition. That of Prof. Donders, used on the Holland roads, I have employed. For reflected light or day-signals we have little disks of colored paper or flag bunting, of certain sizes. These are exhibited to the employe on a black surface at a certain distance. He must quickly name them. If he cannot distinguish the colors at the distance an average normal eye can, then we get a measurement of his defect from the size of the colored disks and the distance he can instantly distinguish them.

For night signals we have in this apparatus a hole in a screen. Over this can be quickly placed the different colored glass, whilst the opening can be varied in size. Behind the screen is a standard candle which slides on a scale. The distance of the candle, the size of the opening, and the distance of the employe, give us the data for the formula which you will find in my manual. When the man never fails to quickly answer as to color, *safety* or *danger*, then we have his limits of color sense.

These two principles have been used in the other quantitative tests that are here. Another and a very different principle is employed by Prof. Holmgren on the Swedish roads. The apparatus is in the Exhibition. It is based on the curious properties of induced colored shadows, so called. It would be impossible to exhibit it to this large audience. I must refer you to my manual for a description of it. All of the apparatus, etc., I shall be glad to show any of you after your meeting.

You thus see that an examiner must be not only familiar with the normal and abnormal color sense, but must be properly equipped with apparatus necessary for his work. The worsted test, in the hands of any experienced experts, will tell us roughly the probable amount of defect, but it would not be fair to an *old* employe, somewhat defective, not to give him the benefit of a careful scientific and reliable *measurement test* to decide his case on.

I think you will now agree with me that "any intelligent boy of 14" is not qualified, and cannot be, to examine and decide on the defective vision of the men under your employ. In the two instances I have been called upon to examine the employes of a railroad, I declined to unless the superintendents would patiently go over the whole subject with me, see my methods of testing, and as far as possible understand the whole subject. We occupied many hours in this mutual study. So far as I could I put these officials in position to do the work of examination themselves. In both instances they reported that they could not, and quite refused so to do. I was employed, and, from the knowledge they had and from watching my tests, they were perfectly satisfied with my decisions, and very glad not to have to make these themselves. There was never the slightest trouble with the employes. They all saw the defective, and how they were dangerous, and were as little anxious to serve with them as were the officials to retain them.

Now those two railroad officials are the only ones who ever studied the subject with me, though I have freely offered to show and explain to any desiring to do so. This association is the only one connected with railroads that has ever asked me to explain and exhibit the subject as I have attempted to do. I therefore felt called upon to do the best I could in the short time that could be allowed me, even at considerable expenditure of my time and money.

I am not without hopes that what I have thus far shown and said will induce the members of this Association to take a proper stand, and study and investigate for themselves this curious subject, that cannot be pushed aside, with those competent to explain it, before they allow on their roads such ridiculous tests as have been and are now being made on the roads where any sort of an official has been directed to undertake them. The Pennsylvania Railroad

Company has been the only one to enter into this matter thoroughly, by a committee of directors studying with a competent expert. The result you well know, viz., the adoption of regulations governing the form and color-perception and the hearing of all employes. By all the defective being carefully tested by their expert, they themselves are convinced of their defect, and see why they cannot retain their posts without danger. Hence there has been no trouble with employes there from politicians and lawyers exciting them against the regulations and any laws of control. Moreover, a State law would ask no more of this corporation, whilst forcing other roads to take the necessary precautions by thorough examination and elimination of the defective from posts of danger and their transference to other employment on the road. The corporations you members represent may safely follow the lead of the Pennsylvania road without fear of trouble from or injustice to the men you employ.

The community as they gradually understand the truth and are disabused of the falsehoods interested persons have plied them with, will demand laws of control. You will be forced to inaugurate such control. As you have seen, to do this without the risk of resistance and with strict justice and impartiality, you must give the time and the study requisite to put you in position to answer intelligently all questions, and be able to defend your position before your employers and before the defective and their friends. From the neglect of such study on the part of those who have had rules and regulations to make and carry out, and on the part of those whose official duty it became to investigate and report, has arisen the trouble you have heard so much of, where State laws have been enacted. This all was wholly unnecessary, and would never have arisen had the warning I repeatedly gave been heeded, and the mistakes in Europe which all experts understood and pointed out been profited by. I have personally spent a great deal of time and money to ward off the natural resistance which I saw was sure to come where absolutely needed regulations were attempted to be introduced without a proper understanding on the part of those entrusted with them.

I have said in my manual that "the interests and safety of the community have to contend with ignorance, prejudice, pecuniary,

considerations and incredulity born of supposed immunity from danger." I could hardly look forward to these having to contend with office-seeking politicians exciting your employers and bidding for their votes by promises to prevent any and all laws of control. Nor could I look forward to wily political lawyers, not only doing this, but at the same time getting heavy fees from the employes by the assessments levied by the committees of their organizations.

Still further I could not look forward, nor could I properly suspect the resistance on the part of the railroads, not to the introduction of control and forced examinations, that is natural and to be anticipated from the reasons I quoted, but I mean the refusal to properly and thoroughly investigate the subject in a way that the community fairly have a right to demand. It is the ignorance from this refusal that has unfortunately induced many officials to stimulate resistance among their employers, and in more or less open way to take part with them against laws of control. The counsel of the employers in Massachusetts read to the railroad legislative committee and published in the papers, as evidence for doing away with the law, letters from many railroad officials exhibiting such ignorance of the whole subject, and such prejudice that even the general community knew better. Some of those letters were only too apparently written as ingenious bids for the votes or favor of the employes. If they were simply due to ignorance then, under the circumstances, this ignorance was culpable in those who wrote them whilst holding the official positions they did. Of such a character was the letter of President Watrous, of the New York and New Haven Railroad, being precisely what I heard him say before the railroad committee of the Connecticut Legislature. He never could have seen the examinations made on his road by the State expert, Prof. Carmalt, and truthfully say or write what he did. You have seen the worsted test. Dr. Carmalt examined by it precisely as I have described, yet Mr. Watrous says: "My own conviction is (founded, I must admit, on not a wide range of experience) that it does not aid an engineer at all in distinguishing the signals, on which observance by him the fate of the train depends, to practice him on skeins of worsted, with their multitude of different shades, such as are likely to be found in a color-blind expert's portfolio." This is quite in character with his further assertion

that he could readily decide, and had so done, on an employe's color sense by asking him the *names of the colors of objects in his office*. You must remember that all the men whom the experts declared color-blind by the worsted test in Connecticut failed to distinguish flags and lanterns, even at the distances they and their counsel demanded of the Board of Health, in whose hands the matter had been placed by the Legislature.

Now the community already knows too much about color-blindness and can appreciate its danger to themselves to let pass such ignorance, if it is such, on the part of a railroad president. Certainly none of you members who have listened to me would like to risk your reputation for intelligence and veracity by now repeating any such nonsense.

If resistance to control was based on knowledge and experience I should be the last to complain. I must, however, in behalf of the community, complain of the more than apathy on the part of those who should investigate this subject as have the directors of the Pennsylvania Railroad. This resistance, combined with an open siding with the employes and their counsel, who are equally wholly ignorant, against control on the part of railroad officials the community will not long endure.

From culpable ignorance and prejudice the worsted test has been so *misapplied* in Massachusetts that I have in arguing before the legislative committees taken the side of the employes against being subjected to such tests in such hands. From this misapplication and the ignorant attempts to use the test by railroad officials a grievance has been fairly established, of which politicians and others availed themselves in exciting the men to pay up their assessments and use the money to pretend to alter, but really do away with, the law of control. Had a proper law of control been made establishing just and fair standards of requirement for color and form perception, with competent disinterested medical men to test for those requirements, there never would have been any opportunity for office seekers to have cheated the men and feathered their own nests at their expense.

STANDARD REQUIREMENTS AND EXPERT TESTING.

These are what I have argued for from the commencement, and

are what the community are bound to have enacted sooner or later. I come before this association to explain and show them, as I have, how and why these are necessary, and to respectfully warn them of the mistakes and blunders made in Connecticut and Massachusetts. A national control may come before it is even suspected as possible. I have proposed an inter-State commission, which I would ask your serious consideration of. It has been repeatedly advised and favored by the press. As you all probably well know, there has been *twice* before Congress a bill, most favorably reported from the Naval Committee, to authorize the President to inaugurate an international commission as to control of defective vision on the ocean. From the Swedish edicts you can read in my book you will see that the countries of Europe await the action of Congress. The President and the heads of departments have called attention to the need of such commission. I speak of this to show you the importance of the subject I present.

DANGERS AND ACCIDENTS FROM DEFECTIVE VISION.

Accidents have been traced directly to color-blindness both on the land and the sea, and are described in my manual. There is no doubt in my mind that others, which have not been explained, have been caused by it. I have never seen an expert's report of the eyesight of employes implicated in an accident, even when the accident has been judicially investigated. The Governmen has traced collisions to color-blind pilots. Our local inspectors at Boston told me frankly that they were at first very skeptical, but that they now from practical experience "were converted more than St. Paul." The number of color-blind pilots who could not distinguish the colored marine lights *across the room*, thoroughly convinced them of the defect being the frequent cause of the accidents they had to investigate, and would explain the apparently "hard swearing" about lights.

There was once *led* into my office a mate who was at the wheel of a steamer that collided with a vessel where 100 lives and both vessels were lost. He had atrophy of the optic nerves, and told me honestly that he had not seen the schooner till she was under his bow. The disease had been going on gradually, and his loss of sight would have been surely detected had his vision been tested each year that his license was renewed. But there was no law

then, *nor is there now,* to require this. Pilots are tested for color-blindness, not for visual power. Masters and mates are *not tested at all for anything.*

Now, if you answer me that is on the ocean, not on railroads, I will quote from the Philadelphia *Medical News* of May 5, 1883, p. 498: "A man who applied at the Wells Hospital with optic atrophy had scarcely vision enough left to drive a cart through the streets in daylight, but had been running express trains filled with hundreds of confiding passengers at night, until he could no longer bear the strain of mental anxiety, and was relieved at his own request. It was enough to make 'each particular hair stand on end' to hear him tell of his experience."

In Connecticut an old engineer who was color-blind refused to be tested and resigned. He went to the expert and gave a similar description of the anxious life he had led that had nearly killed him. He naturally did not understand or appreciate his trouble till it was detected and explained to him.

Did time permit I could detail you very many cases from my private practice, and especially from my hospital work, of both defective vision and color-blindness among seafaring and railroad men. When brought to me by their employers I have always found that the latter discharged them for less defect than I should have, or is permitted by the printed proposed regulations I have placed on the table for your perusal. When young and intelligent engineers cannot distinguish the red and green switch glasses held up in a bright light at 20 feet, and their employer or road superintendent turns to his master mechanic, saying: "My God, we don't want that!" as has occurred in my office, do you blame me for endeavoring to obtain *proper laws* of control, and not the farce of one employe testing another, etc.?

Could the community see and understand what we ophthalmic surgeons do, they would insist upon a control far beyond that we advocate. I have always striven to repress and guide this feeling on the part of the community, and not to excité it against the railroad or the employe. You will find my record very square on this point, notwithstanding the falsehoods placed before you and your men. My personal contact with the latter has always been a pleas-

ant one. The defective and their friends have always been more than satisfied with my decisions. What one of the "boys" said the others will find to be true: "Doctor, you are our best friend." Notwithstanding the present hostility to me, excited by interested and designing persons, time will prove that I am not only the employes' best friend but their *employers'* also.

From the natural conculsion that no one works without pay, but still more from the gross misrepresentation to which I have been subjected, I must here again touch a delicate, because a personal, subject, and repeat what I said at the commencement, viz.; that I expected and have received no pecuniary or other recompense for *any* of my labors for the past six years in the cause of control of defective vision on land and sea. Occasion arose for my saying to your President and Secretary that I expected as little to be reimbursed by this association for my outlay of time and money in coming to Chicago to address you as I should to be reimbursed by Congress for time and expenses in appearing twice before the Naval Committee at Washington upon their request and invitation.

FUTURE PROTECTION OF THE RAILROAD AND MARINE SERVICE.

Notwithstanding so much very many of you have heard against me and the gentlemen who are similarly engaged in the cause of control, as seeking only to attack the railroads for possible future profits, I am doing all in my power to prevent those with defective vision applying for positions they cannot fill.

All expert examiners have found everywhere in the world an extraordinary ignorance of color on the part of us males, no matter hardly what practice or education we had. This, of course, compared to females, who learn colors from their natural surroundings and not from school education. You well know how expert both men and women become in colors where by their vocation their natural color-sense becomes educated. Now I desire to educate the normal color-sense of boys, and have been engaged some years in devising methods of doing this that would be practical. This color chart which I show you I have finally published. It has been adopted by the Boston School Board. There are these little cards to match the spots of color on the chart, and the primary children of the very youngest classes are taught by matching these to *feel*

the colors and also learn shades, etc. But this education will also do what no other has, viz., call the attention of teachers to the color-blind boys from the curious *mis*-matches they will make. The school principal, and, if necessary, an expert, can confirm the presence of the defect, and the children themselves, or their parents or guardians be advised of it, and thus warned not to attempt to seek employment where the defect will throw them out legally, or endeavor to pursue those avocations where color-blindness will be a positive hindrance. You see, therefore, what is my position before the community and my relations to your corporations. I hasten to say that no teaching with the chart in the schools can possibly alter the color-blind children's defect. The chart, moreover, is not in any way intended to detect color-blindness by, but in teaching by it the defect is pretty certain to be discovered. The introduction of proper color-teaching is one of the equally earnest purposes of my labors.

Now, gentlemen, when accepting the invitation extended to me, I wrote your President that I trusted that my personal presentation of the whole subject and explanation of my connection with it would serve to better acquaint you with it and with me. I trust my efforts have not been in vain in either respect. In closing, I would thank you for the very earnest and patient attention with which you have listened to me, and I shall very gladly answer any questions you will please to make, as often such will draw out a better explanation than I have given of any special point which time allowed me to only briefly touch upon.

Coleman Sellers, of Philadelphia—Some time ago I was at a hotel table where this question of color-blindness was discussed. A lady sitting near me said that there was no such thing. I inquired who the lady was. I was told that she was from Boston, and was at the head of the Kindergarten schools. She said she had had a life-long experience in teaching children, and that she really believed that there was no such thing as color-blindness; that children taught on the system you are describing would gradually learn to distinguish colors. I wish to know how far her statement was correct.

Dr. Jeffries smilingly replied: The question is very fairly put. I am glad it was asked, but I am sorry to answer it by saying that the school teacher did not know anything about color-blindness, which she had better quickly instruct herself on or her committee will be

after her. She certainly could hardly be one of the teachers who saw me test any of the 28,000 Boston school children, and she could not be one of the students of the five normal schools of Massachusetts, whom I have carefully instructed in the normal and abnormal color-sense.

Seriously, however, there has been cause for this ignorance. Dr. Favre in France asked his teacher friends to test their children in order to gather statistics. The teachers knew nothing about testing, and tried their scholars by *asking them the names of colors.* They consequently reported as high as 45 per cent. *color-blind,* simply because they did not know the names of colors, just as we adult males do not. Then the teachers went to work to *cure* this supposed color-blindness by teaching colors, and reported that they were very successful, with the exception of about 4 per cent., who were too stupid to be *cured.* These were, of course, the unfortunate truly color-blind. This idea has spread abroad from France, but is now well understood as, I may almost say, a *silly* mistake. Even educated teachers are not expert examiners. I would advise the member's lady friend reading my report to the Boston School Board, and an article on "Education in Color-Teaching," and a glance at my manual before her committee question her about color-blindness and color-teaching, etc. The latter she may have to undertake at any time.

MR. SETCHEL—I move that a vote of thanks be returned to Dr. Jeffries, for his very interesting address.

A vote of thanks to Dr. Jeffries was accordingly given.

MR. J. N. LAUDER, Mexican Valley Railroad—I move that committees be appointed by the Chair for the following purposes: On resolutions; to select a place for holding the next annual meeting; to nominate officers for the ensuing year; to present suitable resolutions on the death of deceased members. Agreed to.

The Chair then appointed the following committees:

On Resolutions—Jacob Johann, George B. Ross and T. B. Twombley.

To select a place for holding the next annual meeting—George B. Ross, John Hewitt and G. A. Coolidge.

To nominate officers for the ensuing year—John H. Flynn, J. T. Gordon and William Swanson.

To prepare a memoir of Mr. Hayes—E. T. Jeffrey.

To prepare a memoir of Mr. Fry—M. N. Forney.

To prepare a memoir of Mr. Martin—W. W. Evans.

The Committee on Finance presented following report, which was read by the Secretary.

CHICAGO, June 20.

To the President and Members of the American ilway Master Mechanics' Association :

Your Committee to audit the accounts of the Secretary and Acting Treasurer, have attended to that duty and find them correct.

JAMES M. BOON,
JOHN H. FLYNN,
GEO. HACKNEY.

The Comm ttee appointed on the application of Angus Sinclair for Associate Membership, reported favorably on that application. On motion of Mr. Lauder, this report was accepted, and the Convention proceeded to ballot for the candidate. The Chair appointed as tellers, Mr. George B. Ross and Mr. W. L. Short. After the balloting the Secretary announced that 33 ballots had been cast, all excepting one in favor of the candidate and the President announced that the applicant had been elected an Associate Member.

The Committee on the best position for check valves presented the following report:

CHICAGO, MAY 1, 1883.

To the American Railway Master Mechanics' Association.

Mr. President and Gentlemen—I some time since received a letter from our Secretary, saying that I had been appointed to make a report on the question, "In what part of the boiler should the check-valve be located, either for pump or injector, to produce the best results?" and although I protested against the appointment, and pleaded incompetency, he held me strictly to the task. * * * * * I do not think it necessary to make a very voluminous report on a question, the general points of which have been practically settled by the experience of scores of locomotive builders. * * * *

I have written to a number of my associates, asking for information, and the results of their experience, but have received answers from only a few of them; those who answered, however, all agree that the only practicable policy is, to place the check away from the fire-box as far as possible.

The only serious objection to this arrangement, is the necessary length of feed pipe exposed to the cold air—no effort is made to protect the pipe leading from injector to check, and with cold air

sing over it at such high velocities, a very large per cent. of it must be lost by radiation.

Theory points to the leg of the fire-box as the best place for the admission of the feed water, as the admission at this point would give better circulation, the water rising rapidly as it becomes heated, and moving to different parts of the boiler with considerable velocity. Then also, the leg being the lowest part of the boiler, cold water is supposed to flow toward that point, and there is a general idea that in this part of the boiler the temperature is the lowest. It would seem therefore, as if this were the proper place for the location of the check.

Acting upon this theory some years since, I placed a check on one of our engines, in the center of forward end of fire-box, about eight inches above the mud-ring.

Within a week from the time that the engine went to work, all stay-bolts within two feet of that check were leaking a stream, and of course I had to take the check off and place it forward.

This feed water was from an injector, and so was quite warm; had it been from a pump and with no attempt at heating, I presume the effect would have been still worse.

My experience therefore is, that the check-valve must be kept as far away from the fire as possible.

On this point I believe nearly all locomotive builders are agreed; but farther than this there is a conspicuous lack of unanimity.

Some say that the check should be placed at a mud-drum located under shell of boiler—others report that with the water they use, mud-drums will fill up so quickly with sediment and scale, that they cannot use them to feed into.

Mr. Boon, of the Chicago and North-Western, recommends the placing of the check under the belly of the boiler, and gives as one of his reasons, that it is a more protected locality, and in case of a rear collision, there is little danger of the check-valve being knocked off, and people scalded by the escaping steam. And as we know of so large a number of serious and fatal accidents having occurred in this manner, I believe that this consideration should have some attention.

There have been numerous unsuccessful efforts made to feed into

a perforated tube, carried along inside of boiler; but this plan ha been given up on account of the large amount of sediment whic would rapidly fill the pipe, making the passage of water through almost impossible.

Of course as you all know, there have been large numbers c smoke-box heaters constructed, mostly of coils of pipe in som form or another; these also have not been generally successfu because they cluttered the smoke-box so that the draft was ol structed, and pipes containing cold water, placed in the smoke-bo will "sweat" and soon become covered with soot, and when s covered they loose their conducting power.

Formerly I practiced placing the check-valve at about the cent of the forward sheet, and below the water-line, but when so locate I had some little trouble with a few of the flues with which th cold water came in contact.

I then changed the feed pipe, running it through the side of th smoke-box, and into the flue sheet, with the check-valve just ou side of smoke-box.

This gives the water entering the boiler a motion parallel wi the flues, and it seems to have no bad effect on them, for with th arrangement we have no trouble with leaky flues in the vicinity the check.

I have no doubt that a large number of the members presen can relate their troubles and experiments in this matter, and u doubtedly an open discussion would be more productive of info mation than the researches of any one man.

Respectfully,

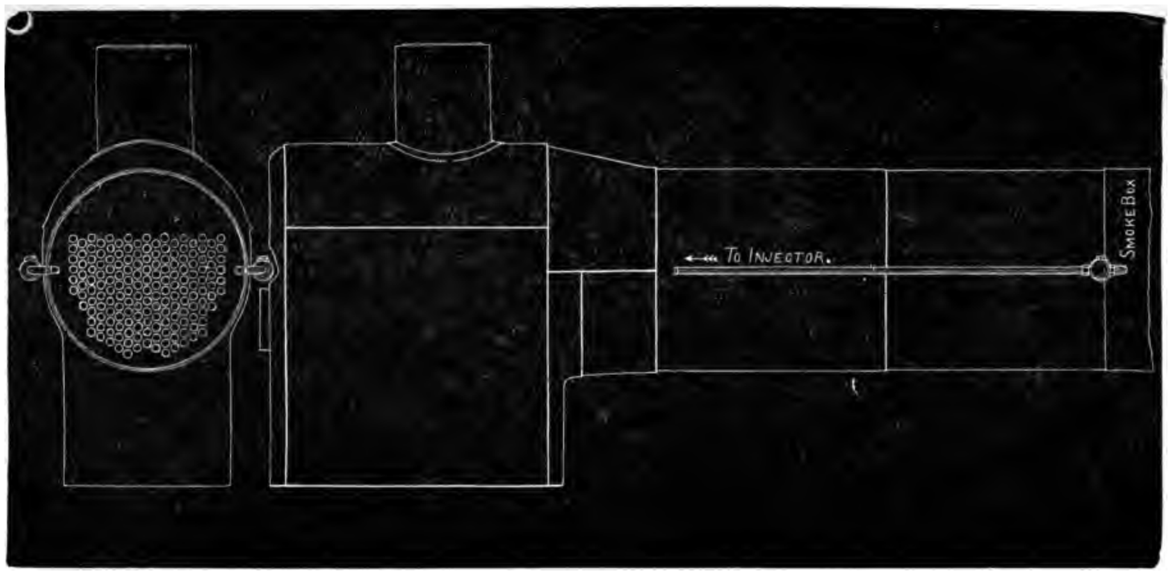
THOS. B. TWOMBLY,

Chicago, Rock Island and Pacific R. I

On motion report was received.

THE PRESIDENT—The subject is now open for discussion.

MR. CASCADDIN, Chicago, Rock Island and Pacific Railroad—As have been using that I wish to make a few remarks as to my experien in the matter. We had some new engines with the injector place about in the middle of the boiler, half way the length of the flues. The gave me some trouble. had to t ke the flues out and I found that th sediment had collected back close to the fire box, which caused them leak. I replaced the flues and it was but a little while before I had take them out again. I placed them in on the front end just forward



Chicago, Rock Island and Pacific R. R. method of attaching Check Valve—Thos. B. Twombly, M. M.

it must become smaller. There have been many attempts to produce a reamer which will be adjustable. Thanks to the gentlemen

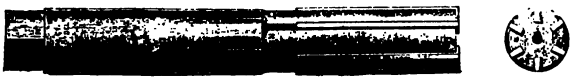


FIG. 1.

who are now making such tools a specialty, there now has been added a very useful tool to the machine shop. Here is a reamer (fig. 1) made by the Betts Machine Company, of Wilmington. In this the straight cutter blades are made wedge-shape on their back edge, and are seated in wedge-shaped or taper grooves, to match the taper of the blades; these blades can be set to fit a standard gauge.

This will enable us to make and maintain a commercially uniform hole in our work. But the successful use of a reamer of this kind depends upon the drills that precede the reamer, being made as nearly right to size as possible; in other words, that the reamer has as little work given it to do as possible. The less you give a reamer to do the longer it will last and the longer it will maintain its size. The question of tapered bolts involves at once this difficulty, that we have to drill straight holes; then the tapered reamer is obliged to take out all the metal that must be removed in order to convert a straight into a tapered hole. The straight hole reamer is maintained to size longest by taking out the least amount of

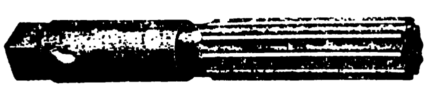


FIG. 2.

ietal. Hence it follows that the tapered reamer would be the earest right for durability, which also would take out the least nount of metal. A short reamer like that (see fig. 2) will swer for a hole of a very considerable depth. It is only cessary that the length of the reamer shall be three or four times own diameter. The Pratt & Whitney Co., has furnished me h reamers made for the Baldwin Locomotive Works. These reamers that are to do precisely the work that we now have

under consideration. They are to make a tapered hole, but you will observe the difference in lengths between the two. The straight 1¼ in. reamer is say 4 in. long in the blades, the taper reamer is say 20 in. long.

Let us now consider the question of amount of the taper. No round piece of iron can go into a round hole in another piece of iron unless it is smaller than the hole into which it is intended to go. If it is in any degree larger it must compress the plug itself, or stretch the material that is around the hole. So if we adopt a tapered bolt we cannot fix upon a certain uniform distance that each and all bolts shall stand out before we begin to drive them. If the material is to be compressed, you will admit that there is a great deal more material capable of being compressed in a piece of large diameter than in one of small diameter. Metal is elastic; as long as we keep within the elastic limit of the metal, we are safe in assuming that it acts like a spring. In the large bolt and in the small one we have springs of different lengths. In the large bolt we have a long spring and in the small one we have a short spring. If we drive a bolt into a large piece of iron, it is the bolt which we compress; therefore the larger the bolt, the more the pressure we can give it to produce the required result. Therefore if we adopt any fixed taper for our bolts, we will have to use discretion, or go into an elaborate series of experiments, as to how far we should let our bolt-head stand away from the work before we begin to drive it. Now I find varying practice obtaining in locomotive establishments. There are some builders of locomotives (I mean connected with railroads) who put the straps upon their stub ends with tapered bolts, but do not use tapered bolts in any other parts of the structure. The Baldwin Works use tapered bolts wherever they require body-bound bolts. They make an universal taper of $\frac{1}{16}$ in. to the foot in diameter. Suppose it is an inch bolt we are dealing with, and an inch bolt 12 in. long, and we started with an inch, and we ran it up to a taper of $\frac{1}{16}$ in., it would result in this being $\frac{1}{16}$ larger under the head than at the point.

They make all their bolts which are under 9 in. in length $\frac{1}{16}$ in. larger under the head than the name of the bolt. Thus a ¾ in. bolt is made $\frac{13}{16}$ under the head, provided that bolt is 9 in. long or under. Anything over 9 in. long is made ⅛ in. larger under the

head and still made a taper of $\frac{1}{16}$ in. to the foot. Most of the bolts used in locomotives are under 9 in. long. I have been shown bolts 20 to 22 in. long that were made a taper of $\frac{1}{16}$ in. to the foot, and those were the bolts that fastened the saddle and the frame together: practically, however, the great bulk of bolts that are used about locomotives are those which are less than 9 in. in length and come under the category of $\frac{1}{16}$ in. to the foot, and $\frac{1}{16}$ in. larger under the head than the name of the bolt. A locomotive builder now in this city tells me that the specifications of engines submitted to him in many cases name the required tapers for all bolts —some call for $\frac{1}{8}$ in. to the foot. The Pennsylvania road calls for $\frac{3}{32}$ in. to the foot. All Baldwin locomotives are $\frac{1}{16}$ in. to the foot. He tells me that the majority of the specifications, if they do prescribe the taper at all, ask for $\frac{1}{16}$, with the exception of the Pennsylvania. The advantage of the $\frac{1}{16}$ would seem to lie in the fact that a bolt headed in the ordinary manner can be made to fill the requirements, provided it is made of iron $\frac{1}{8}$ in. larger than name of bolt. For the purpose of discussing this question at the present time it would be as well for us merely to adopt some taper which I should say might be $\frac{1}{16}$ in. to the foot, and carry that through the system of gauges I propose to show you, so as to enable us to judge whether it is a practical system, and how far we can use it. If we shall decide that bolts should be tapered, for the reason that when a tapered bolt is driven into its place it can be readily knocked loose, if that tapered bolt, when it is in, proves to be too loose, we have merely to turn out under the head and drive it a little further. These are arguments in favor of the tapered bolts, and show why it is an advantage to use them, their use rendering it easier to repair work that is secured by them than work that has straight bolts. If we adopt a tapered bolt, and let us say with a taper of $\frac{1}{16}$ in. to the foot, it is then well to make up our mind how we are going to make bolts, and bore the taper holes in a commercial manner; in other words, so that it can be brought into what we call the interchangeable system.

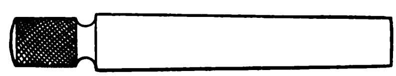
No matter what taper is adopted, either, by general consent uniform among the shops and the railroads or different in any of them, yet there is always the same need for a system of gauges to carry out the principle in each shop. The Baldwin Locomotive Works,

having used the taper system for many years and considering it essential, long ago perfected a system of gauges which seem to me to meet the case. This system may be explained as follows:

For each diameter of bolt, and for all bolts under 9 inches in length, they keep in their store room steel plugs ground to a taper of $\frac{1}{16}$ in. to the foot in length, and each standard plug is made at its largest end exactly $\frac{1}{16}$ in. larger in diameter than the name of the bolt it represents. Thus for a one-inch bolt the standard plug will be on the taper part say 6 in. long, and one end of it will be $1\frac{1}{16}$ in. diameter, and the other end will be $1\frac{1}{32}$ in. in diameter, a convenient milled handle being provided beyond the large end of the gauge, as in fig. 3.

To this standard plug is fitted a ring gauge or female gauge of

FIG. 3.



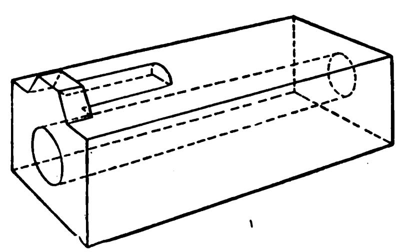


FIG. 4.

any convenient external form, which is in length the same as the taper part of the standard plug; so that when the hole and the plug are clean and dry, the one should just fit and fill the other and come flush at the upper end. These plugs and rings are to be retained in the store room as standard to try other gauges by. It is stated that the large majority of bolts used on a locomotive and made taper, can on the taper of $\frac{1}{16}$ in. to the foot, be driven home if the size of the bolt and hole is such as will cause the head of the bolt to stand above the top of hole one-eighth of an inch, and when such a bolt has been driven home it will have compressed the

bolt or stretched the metal into which it has been driven to the amount of .0065 in., and the fit will be almost as tight as are car wheels forced on to their axle in the usual manner. The gauges used by the workmen at the turning lathes for bolt work are made of cast-iron similar to the gauge described in connection with the steel plug, but are rectangular, so as to rest well on the lathe bed in a handy position for trial, and on each one of these gauges is cast the representation of one-half of the kind of bolt it is used for, as for example one for hexagon head bolt, and one for countersunk head bolts. See fig. 4.

The bench, or rather lathe gauge, for an inch bolt may be, say 6 in. long and $2\frac{1}{4}$ in. square; the same sized casting, in fact, may be used for several sizes of bolts. These lathe gauges are reamed to such a size that the standard plug in the store room will be flush with the top of the gauge, precisely as is the case with the standard ring in the store room on the same plug. Bolts turned taper must fit this gauge with the head just touching the top of the gauge, and without rattle or shake over the length of the gauge. The reamers used for tapering the holes in the shop should be not only long enough to enter the hole drilled and tapered to the required size, but there should be several inches left at the large end to allow for redressing; thus a one-inch reamer should be one inch in diameter at its small end, at one foot from small end it should be $1\frac{1}{16}$ in. in diameter, and if beyond this it continues at the same taper, say three inches, it should measure $1\frac{5}{64}$ in. diameter at its largest end. Such a reamer may be reground until its largest diameter has been reduced to the standard size. These reamers are guarded at their upper end by a collar driven on and covering the entire unused part of the reamer, which collar can from time to time be dressed off at the lower end to gauge, to keep the size correct. To adjust the reamers there are kept in the store room a set of rings, one for each size of bolt, which are so sized that the standard plug does not enter flush, but stands out one-eighth of an inch. It is well, too, to retain in the store room reamers not guarded at the large end, which can be used from time to time in retapering the gauges in use at the shop. Figuring or lettering on the gauges should not be on the upper end, as that part in readjusting requires to be turned away.

The same system of gauges for the bolts that are $\frac{1}{16}$ in. larger under the head than the name of the bolt, and which bolts are 9 in. long or under, can be carried out in making the bolts that are $\frac{1}{8}$ in. larger under the head and are 9 in. long. The outfit required, therefore, is for the store room: one plug gauge and one female gauge to match for each size of bolt, and for each kind of bolt, whether under or over 9 in. long; one ring or female gauge for the adjustment of the reamers, with the hole as much smaller than the bolt as will give the proper compression, and one standard reamer for the adjustment of the gauges. In the shop the gauges are female for the bolts and the guarded reamers for making the holes.

The taper bolt system calls for the use of two lathes to make each bolt, one to turn the cylindrical apart for the screw thread and to square up under the head, the other lathe set to a uniform taper, not by the setting over of the head, but by means of some good former attachment, that will insure infoimity of taper regardless of the length of the bolt. In the first lathe the gauges used may with advantage be such as these very fine snap gauges made by the Pratt & Whitney Co., of drop-forged steel, or those made by the Betts Co., of Wilmington, Delaware. (Both makes of snap gauges were shown.) With a double ended gauge the cylindrical end of the bolt can be made ready for the screw lathe or the bolt cutter, and with the larger gauge $\frac{1}{16}$ larger, the diameter under the head can be brought to size, and this sized part can be utilized to start the taper in the taper lathe, either starting the cut at that part or setting the tool to a stop screw in the rest at the large diameter, backing off and entering the cut at the small end of the bolt, and turning up toward the head. In practice it is found that the size and taper can be readily hit, and the gauge has very little wear from excessive use and repeated trials. When turned to size the bolt should fit the taper gauge with no shake and the head just touching the end of the lathe. The inspector in the bolt store room should also examine the bolts with the taper gauge before putting them into stock. By means of the standards in the tool room the gauges for the lathe and the taper reamers can be kept to size. There are now to be had very convenient tools arranged for grinding the cutting edges of reamers to any required taper.

It is the practice with some users of taper body-bound bolts to

only taper the holes to a depth equal to the thickness of the thinnest piece to be secured. As, for example, where the braces from the boiler are attached to the thick frame, they will ream the hole taper through the brace foot and for an equal depth into the frame, and while the bolt is made tapered down to the thread it will not fit the hole anywhere below the taper part of the hole. If a drill $1\frac{3}{64}$ in. diameter be used to drill the hole for an inch bolt, and the drilled hole be reamed out to near $1\frac{1}{16}$ at the top, the taper will be for a depth of 3 in. only; quite enough bearing to hold a foot $1\frac{1}{2}$ in. thick in place.

Having described the system of gauges to you and explained some of the uses and advantages of taper bolts under certain conditions, I do not feel prepared to report in favor of any particular taper for such bolts. The question of uniformity of taper in the body of bolts, while it is of importance as tending to interchangeability, yet involves more important considerations than in the change of the threads used on the bolts themselves. The taper hole for the bolt in any machine becomes part of the machine. The bolt itself, a movable piece, may be put into such a hole with any one of a dozen kinds of threads cu on its end. The taper that has already been adopted in any shop or on any road requires that all future work shall conform to it.

If the Pennsylvania Railroad and all its branches have adopted $\frac{3}{32}$ it is folly to ask them to change it to 1 in., because their own connections are large enough to make them independent of almost any other corporation, and the need of absolute uniformity in their work would cause them to stick to that particular taper. Any of you having five, six, seven, or two or three hundred locomotives must make up your minds what you will do. When we changed the standard for screw threads, a screw thread was adopted which had a manifest advantage. It is easy to adopt a screw thread. A bolt with any kind of screw thread can be used on any machine. But once having adopted a taper for the body of bolts on a road it is very difficult to make a change; and whether it is wisdom for this Association to say that any particular taper shall be the standard, is a question that I am entirely unable to answer. Therefore I am unwilling to recommend any taper to you, and only present the facts; but I will say that $\frac{1}{16}$ in. is enough. The less taper you

have the less material you have to cut away. But to say that $\frac{1}{16}$ is preferable to $\frac{3}{32}$ is folly, because no human being could feel the difference. If a bolt has 5 degrees taper it will set well; if it has 6 or 7 degrees it may jump out. Five degrees is about the angle of friction for iron. Five degrees would be an absurd angle for a taper. Any taper, then, that will hold the bolt when driven in, will answer the purpose. I think that the presentation which I have made, showing you a system of gauges which is already in use by those who have had long experience, may enable you to discuss the matter, so as to arrive at some conclusion as to whether you will adopt a uniform taper or whether you will let things go as they are. Nothing is more desirable than an interchangeable system; and while it is undoubtedly advantageous to make all parts of machines on the interchangeable system, yet in the matter of making holes to size there is a very good illustration of the difficulty enumerated taken from work with which I am familiar. In making turning lathes, the part that the longest resisted this uniformity was the sliding spindle of the dead head. Spindles may be made very close to size, but not so close but that each spindle must be fitted to place in the hole ground out to receive it, this for the reason that any shake or looseness other than that which will permit freedom of motion is detrimental, and it was not until the plan was adopted of arranging conical self-centering clamps to each end of the bearing of the dead head spindle that such spindles could be made to gauge, and thus added to the list of the interchangeable parts of the machine.

In conclusion, it seems to me that the consideration of the uniformity of taper should be entered upon with caution; but from what I have presented to you as bearing on the facts of the case, you must be quite as well prepared to debate the question as if I had urged the adoption of any particular standard taper. If you do not see fit to consider the question, the system of gauges as used by the Baldwin Locomotive Works will enable those who desire to systematize their taper bolt making, and to carry it to a reasonable degree of uniformity in their shops.

Mr. Setchel moved the report be received.

Carried.

MR. SPRAGUE, H. K. Porter & Co—This matter seems to be something in the same line as that concerning which I suggested to the members last year, to consider the expedience of appointing a committee upon, namely, shop tools and machinery. In view of the accuracy of work, it seems to me that that is one of the economies which is just as useful to railroad mechanics as the economy in fuel. I have not been able to understand why there is so much apathy manifested in reference to these matters. I am satisfied that any of us have appliances in our works for economizing work that would be useful to all the members; and I made an honest endeavor, I think, last year to draw out those points, but I signally failed, and consequently failed to be able to make a report that would be satisfactory to me. And while I do not believe that the Convention has arrived at that point yet, where they could take hold of such a committee heartily, I believe that the time is coming and will come before long.

THE PRESIDENT—I will state for Mr. Sprague's information that we have a committee on subjects. If he has anything that he would like to have investigated, he can present it to them and let them present it to the Convention.

MR. SPRAGUE—I do not understand that that committee would take hold of this matter in the sense in which I look at it. My idea in this matter was to determine if any one man knew better than another, for instance, what classes of work it was desirable to mill, what classes of work it was desirable to grind and polish. I do not understand that we have such a committee as that.

THE PRESIDENT—We have a committee called the Committee on Subjects. It is a standing committee of three members. One member is elected each year. When a member is elected, he is elected for three years; one of this committee goes out every year, and any subjects which any member has which he would like to have investigated he can present to that committee, and let them present it along with other questions, for the appointment of a committee or that particular subject.

MR. SPRAGUE—I wish to say that I understand that matter thoroughly, and I understand that there has been an effort within the last three or four years to excite an interest in the members in such an investigation, but it would be useless to appoint a committee on that subject if you cannot get the members to act on it. I wrote a special circular to each of the members who are locomotive builders, and I failed to get matter enough to make a report on that subject, and it would be useless to appoint a committee on the subject again unless we are satisfied that

our members would take enough interest in it to profit by it and do some good.

MR. SELLERS—It seems to me that very little comes of anything of this kind; unless some of the members offer a resolution that such a thing should be adopted. If there is no such resolution offered, evidently there is no desire to have a standard adopted. If anyone feels that such uniformity is needed, he will offer a resolution that this, that, or the other taper should be adopted.

MR. SPRAGUE—The way I have felt on that subject is that I wished the members would think of the matter and say if they were prepared this year to go into an investigation of that kind I do not see any interest so far as I have observed, but I think it will come in time. But to appoint another committee to make another failure, I think, would be an injury to the cause. Consequently I feel disposed to wait a few years until the members are sufficiently awakened to take some intere in it.

THE PRESIDENT—Will the Convention take any action in regard to the recommendation of the standard taper? If there is nothing further, we will pass on to the next matter.

MR. BLACK—I move that a vote of thanks be tendered to Mr. Sellers for his very able report on standard reamers. Agreed to.

MR. SETCHEL, Ohio and Mississippi Railroad—I think with Mr. Sprague, that the subject of shop tools and machinery is very important, and I am in favor of having a committee on that subject this year; and I move that a committee on shop tools and machinery be added to the list of the committees on subiects. Agreed to.

The Committee to whom was referred the question, "Is the use of metallic packing desirable?" presented the following report:

To the American Railway Master Mechanics' Association:

Mr. President and Gentlemen—Your committee appointed to ascertain the desirability of using Metallic packing for locomotive piston rods and valve stems, beg leave to submit the following:

In order that the Association receive the benefit of a general expression of opinion on the subject, I mailed the following interrogatories to the Master Mechanics and Superintendents of machinery of seventy-five of the principal railroads.

Question No. 1.—*Are you using metallic packing on any of your engines; if so, how many?*

Question No. 2.—*How does it compare with other kinds as to wear on piston rods and valve stems?*

Question No. 3.—*What is the cost per annum for repairs? And any suggestion deemed beneficial to the Association on the subject is solicited.*

In reply to my inquiries, the Master Mechanics representing the following named railroads, reported having no experience with metallic packing, were unable to give the desired information, viz.: The Georgia Railroad Co.; Carolina Central Railroad; the Midland Railroad of Canada; Canada Southern Railroad; Lake Shore & Michigan Southern Railroad; Cincinnati, Hamilton & Dayton Railroad; Atchison, Topeka and Santa Fe Railroad; C. & D. Railroad; Flint & Pere Marquette Railroad; Arkansas Midland Railroad; Hartford & Connecticut Western Railroad; Louisville & Nashville Railroad; New York, Lake Erie & Western Railroad; Central Railroad and Banking Co.

As it is my desire, that this Association may be thoroughly conversant as to the merits or demerits of metallic packing for the purposes above mentioned, I have concluded that the better mode for accomplishing that, is to report "in substance," the verdict of each Railroad Representative, and from the whole the Convention will be better able to arrive at an intelligent conclusion.

CHICAGO & ROCK ISLAND RAILWAY.

"We have the Jerome metallic packing on 60 engines, and are putting it on all new engines built, and on the old ones as fast as they come for repairs. Its action on piston and valve rods is much more satisfactory than any packing I have ever used. Estimated cost of repairs per annum is $3.

It is no uncommon occurance for an engine to run for 16 months with one set of packing rings with no leaking or trouble of any kind. The wear on piston rods is less then $\frac{1}{16}$ inch in two years. The metallic packing is perfectly satisfactory and much superior to hemp or asbestos." [Signed,] THOS. B. TWOMBLY, M. M.

CHICAGO & IOWA RAILROAD.

"We have adopted the Jerome metallic packing for piston and valve rods, having so far seven engines equipped with it.

The wear to pistons is about 90 per cent. less than with the ordinary soap stone packing, and 50 per cent. less on valve rods. Cost to keep it in repair has not exceeded $3.00 per year."

[Signed,] H. S. BRYAN, M. M.

CONNECTICUT RIVER RAILROAD.

"We are using the United States metallic packing on six engines and in comparison with other packing, I think it is preferable."

[Signed,] W. H. STEARNS, M. M.

PHILADELPHIA, WILMINGTON & BALTIMORE RAILROAD.

"We are using the United States metallic packing on piston rods of four engines and valve stems of one engine. I have found that the pistons fitted with this packing will last much longer than with ordinary packing, running sometimes two years without turning. On the valve stems it does not do so well, as it wears them much faster. This I attribute to the fact that the pressure is constant on the packing while engine is using steam, while on the piston the pressure is on the packing not half the time.

I have found also, that the babbitt rings on valve stems wear much faster than on pistons. The wear on valve stems, I have found to be nearly as great with this packing as with good packing used in the ordinary way. I am satisfied that its use on the piston is much cheaper, while for valve stems I do not consider it of much advantage."

[Signed,] H. D. GORDON, G. F.
S. A. HODGMAN, M. of M.

JEFFERSON, MADISON & INDIANAPOLIS RAILROAD.

"Some years ago there were several engines on this road equipped with metallic packing in piston glands, but the wear was so much greater on piston rods, and leakage much greater than with ordinary packing, that it was abandoned. We have however, two engines with it yet; those engines are employed on incline plane at Madison, Indiana. There we think the metallic packing in piston is indispensable, owing to the fact that in going down hill those engines use the compression of air in the cylinders, 'the valve gear being reserved' to regulate their speed descending the hill, and in so doing, the piston rods do not have the advantage of steam as a lubricant so that ordinary packing is soon burnt out.

As before intimated, the work on the Madison hill being peculiar to itself I cannot give you any particulars as to comparison in cost for repairs, &c."

[Signed,] WM. SWANSTON, M. M.

WILMINGTON AND WELDON RAILROAD,

"We have used the different kinds of metallic packing on piston rods and valve stems but do not like it, and have none in use now. I do not consider it as good as the ordinary packing in common use."

[Signed,] JOHN F. DIVINE, Gen'l Supt.

NEW YORK, WEST SHORE & BUFFALO RAILROAD.

"We have adopted the metallic packing as a standard for all our engines and use no other, Have at present sixty engines equipped with this packing, some of which have been in service the past ten months and up to the present I am unaware of any renewals.

"I consider it far superior to common packing. Its wear on piston and valve rods is almost imperceptible, and being truly cylindrical does not groove the rods like common packing."

[Signed,] JOHN PLAGED, M. E.

CENTRAL RAILROAD OF NEW JERSEY.

"We put on two sets of metallic packing made by the United States Metallic Packing Company for trial, that on piston rods worked very satisfactory but on valve stems did not do so well, on account of carrying arrangements not being perfected.

The wear on rods was regular and true, which is the opposite result when fibrous packing is used."

[Signed,] WM. WOODCOCK, M. M.

CHICAGO & NORTH WESTERN RAILROAD.

"Several years ago I experimented with metallic packing, and was not favorably impressed with it. I found it cost about seven dollars per annum for each engine when hemp was used. The packing I tried was a patented article, the royalty was ten dollars per engine, and cost about twenty dollars per engine to fit up. It ran successfully for about one year. when new rings were needed. I could not discern any less wear in the rods with the metallic than with hemp packing, so we abandoned its use.

With metallic packing more care is needed in setting up than with hemp. When there is a careful man on the engine who remains with it, better results is obtainable.

On a road where there are a large number of engines and men are being frequently changed, trouble is inevitable when metallic packing is used. The packing I experimented with was gotten up in the shape of two cones, slightly tapered, (one linked within the other). Steam blowed through and the engineer screwed it up too tight, wedging both together, so that the rock shaft broke in trying to start the engine. I think when the first cost of metallic packing is considered, the royality added, the total amount will pay for hemp packing for a long time. The metallic packing that I have seen needs too much care to keep in order, and experience shows that this care is not given, hence trouble and expense."

[Signed,] JAS. M. BOON, Ass't Sup't M. P. & Machy.

FITCHBURG RAILROAD.

"We have one hundred engines on the road, all of which are fitted up with metallic packing which gives good satisfaction. The wear on piston and valve rods is much less than with soft packing. I think ten dollars would cover the cost of repairs per annum for each engine.

Some of our engines run two or three years, without any repairs to those parts. We use the United States metallic packing."

[Signed,] W. A. FOSTER, M. M.

BOSTON & PROVIDENCE RAILROAD.

"We have metallic packing on piston rods of two engines and on three sets of valve stems. From my limited experience with it I am not well pleased with its service."

[Signed,] GEO. RICHARDS, M. M.

OHIO & MISSISSIPPI RAILROAD.

"We have used a combination of rubber and metallic packing on the valve stems of ten engines on the Springfield Division for the past six months, and Mr. Stokes, M. M., reports that it gives very good satisfaction, costing only an occasional renewing of the rubber to keep it in good working order.

The first cost is about $3.00 per engine for valve stems only.

We do not say this is the best kind in use, but it is a great improvement on hemp, and wears the valve stems but very little. I

have used a concave rubber filled in with hemp, which gives good satisfaction, but believe a metallic packing can be gotten up that will give better results."

[Signed,] J. H. SETCHEL, Gen'l M. M.

NEW YORK, PENNSYLVANIA & OHIO RAILROAD.

"We have over two hundred locomotives equipped with the United States Metallic Company's packing. Its wear on piston rods and valve stems is so near cylindrical, that once in three years is as often as rods require to be turned up. In fact piston rods if properly cared for, will run five years before they require turning.

The cost per annum to maintain this packing, is about four dollars and seventy cents per engine, while the hemp and other kinds used, cost from $25 to $30 for packing, besides the excessive wear and friction on the piston and valve stems which is practically got rid of by using the metallic packing made of babbitt metal.

I have been using this kind of packing for seven years with excellent success and would not know how to get along without it, if forced to return to the old kinds of packing.

There are great advantages derived from its use in the saving of wear &c., of piston and valve rods. The engine is always ready for service when needed without having to go through the stereotype routine of "packing my engine before I go out" if an extra trip is required from the engineer."

[Signed,] WM. FULLER, Gen'l M. M.

KANSAS CITY, FORT SCOTT & GULF RAILROAD.

"We have been using metallic packing on our engines for four years, and have about fifty engines equipped with it.

The wear on the piston and valve rods is not more than one-fifth as much as when packed with hemp.

I find the success of metallic packing depends largely on having the rods kept well lubricated. I have so far had no occasion to turn off piston rods which have been in engines for four years. Once the engine equipped, the cost for repairs does not exceed one dollar per annum.

The difficulty in keeping valve stems packed, is due chiefly to the unequal wear, on account of the variation of the travel, and to reduce this to the lowest minimum I have adopted the plan of a case-hardened sleeve or valve stems, which works well.

Taking everything in consideration I must say from my experience, that the metallic packing is much superior to any other kind known to me."

[Signed,] J. S. McCRUM, M. M.

MISSOURI PACIFIC RAILROAD.

"We are using Hewitt's piston rod packing on over three hundred engines. It wears several times longer than hemp packing, and preserves the face of the rod in a very smooth and perfect condition.

The cost per annum for repairs does not exceed one dollar per engine, exclusive of work done when engine is in shop, for general repairs.

We have piston rods running with it in engines that have made over (100,000) one hundred thousand miles and yet in good condition. There is no extra skill required, either to make or apply this kind of packing, and if rings are put in alternately, it needs no attention except to take up slack of jamb nuts about once in five hundred miles of service.

The metal best adopted, is an alloy of lead and antimony, about five or six per cent. of antimony to about ninety four or ninety five per cent. of lead."

[Signed,] JOHN HEWITT, Sup't M. P. & Machy.

The foregoing being an expression of opinion from different Railroads, as the results of practical demonstration, will, I hope be of interest to all concerned in railroad economy.

So far as my personal experience on the subject is concerned, I will state that we have sixteen engines equipped with metallic packing in piston rods and valve stems. Its use for pistons I do not hesitate to say that it excels anything I have ever used for that purpose, but I must admit its results on valve stems is unsatisfactory with us. The different mode of its appliance, doubtless

gives various results. I simply state my experience with it for each purpose.

As may be seen by my inquiries, my object is not to ascertain what particular kind is preferable, but rather is any kind of metallic packing desirable. I will not therefore dwell on the merits of each, but inasmuch as the replies mentioned the particular kinds (in many cases) I also let it appear in this report, thinking it may be beneficial to the interests which we have assembled here to represent. Before closing this report I wish to take this opportunity of returning my sincere thanks to the different Master Mechanics, &c., who so kindly responded to my inquiries, and by that means aided me to perform the pleasing duty of contributing some beneficial information towards the progress and advancement of American Railway interests.

Yours very respectfully,

R. H. BRIGGS, M. M. Mobile & Ohio,

Chairman of Committee.

The report was accepted.

MR. SETCHEL, Ohio and Mississippi Railroad—In regard to hemp packing you may have noticed that in the report of Mr. Fuller, of the New York, Pennsylvania and Ohio, he states that the cost of packing per year with hemp is from $25 to $30. It seems to me that that is too much. I made a test some years ago in this matter, and I think that the total cost—we used nothing else but hemp—of our packing was seven dollars and thirty cents per engine for the whole year. You will notice in reference to the metallic packing that has been spoken of that the royalty amounts to more than the hemp packing costs for the whole year. Then the cost of putting it in is much more, and then the cost of maintaining it in several cases is very nearly equal to the cost of using hemp.

MR. LYNE, American Machinist—There is one thing here in connection with this report that I would like to call attention to, which is that where this metallic packing has failed, it has been owing in the majority of cases to the construction of the packing. It should not be taken that this metallic packing which is made of two cones is in the proper form, because it is not. The proper metallic packing ought to be self adjusting, so that when once put in it should require no attention from the engineer until it is ready to be taken out. I had a little experience with that cone-shaped packing. If it is screwed up too tight, the expansion will pinch the rod, and consequently the friction is much

more than in any fibrous packing which you can put in, and it cannot possibly give satifaction. Another thing, that packing is rigid. What mean by that is that it fits the internal diameter of the stuffing box, and also pinches the rod. We all know that in process of time, the piston wears down and the cross-head wears up, and in a short time you will find a leak. Then if you attempt to screw them up you pinch the rod on the side, and increase the friction there. Now a metallic packing, which I claim is the only proper packing to use on piston rods and valve stems, should be self-adjusting. If the water passes through there so much the better, but steam ought not to pass. There are metallic packings that are successful. On a straight line engine, with which some of you are familiar, simply a round finger is slotted over the piston rod, and of sufficient length to permit grooves being turned inside. These bushings run for years. Whenever they wear so to leak they are put upon a mandril and put into a tube where there is water; a piston is put in, and by constantly striking that piston with a sledge, the pressure closes the bushing into the standard size. I claim that fibrous packing is a bad thing on piston rods and valve stems, because it will take up and hold all the grit with which it comes in contact, and I have seen piston rods scratched one-thirty-second of an inch deep, 48 hours after the engine left the shop. A properly constructed adjustable metallic packing is far superior to anything else, in my estimation, and in adopting a metallic packing we ought to use a very careful discrimination as to these qualities. The packing ought to conform to the piston rods. In other words, it ought to have an up movement and an angular movement. Any packing that will not conform to those conditions will not be a success on a locomotive. With reference to the packing on a valve stem, it does not give success there because the valve stem wears the smallest in the middle of the stroke owing to the change in the travel of the valve. There is a master mechanic present who has, I believe, a successful metallic packing at work on valve stems. It is different from anything I have seen before, and it conforms, according to my ideas, a little better to the conditions that exist than anything I have ever tried. The same packing used on a piston rod will not work on a valve stem because it has to expand and contract at each revolution of the traverse.

MR. SETCHEL, Ohio and Mississippi Railroad—The gentleman states that where metallic packing has failed, it has failed because it has been badly fitted up. I suggest that where hemp packing has cut the piston, it has been because it was badly packed. I never saw either a valve stem or a piston-rod cut that was properly packed; and if we have to pay as much a year to keep the metallic packing up, and as much

more for royalty as the hemp packing costs, it seems to me it is not profitable in dollars and cents to the railroad companies.

A MEMBER—Do I understand there is a continued royalty on this metallic packing?

THE PRESIDENT—I presume there is a royalty on most metallic packings.

THE MEMBER—I understand that; but do the companies have to pay a yearly royalty? I understand that when the metallic packing is bought, so far as the company is concerned, they get the right to use that on their locomotives.

THE PRESIDENT—That is generally included in the first payment. They buy the right to use or buy the packing.

MR. ROSS—I would like to ask if in the cost of the hemp packing, the cost of the labor was included, in that $7 per engine?

MR. SETCHEL—No, sir, the cost of labor comes in with the labor of the engineer.

MR. LYNE—These testimonials are in favor of it. The rods are not much worn. They have a very fine surface and there is little or no trouble with the packing. When once you get a metallic packing in good working order, it will continue so for a long time. If you can trust engineers to pack with hemp as you would do it yourself, then there might be some advantage in using hemp, but you all know every man has his own particular ideas.

MR. SPRAGUE, H. K. Porter & Co.—It seems to me that we ought to educate men to do the work as it ought to be done. I am not willing to give way to say if you had good men to do this, it would be a success. If that thing can be a success by careful management, we should calculate to make it a success; we should calculate to make our men careful to give it proper attention.

On motion the discussion was closed.

THE PRESIDENT—The next business before the Convention will be the reading of a paper by Mr. Lyne on the application of the indicator to locomotives.

Mr. Lyne then read the following paper:

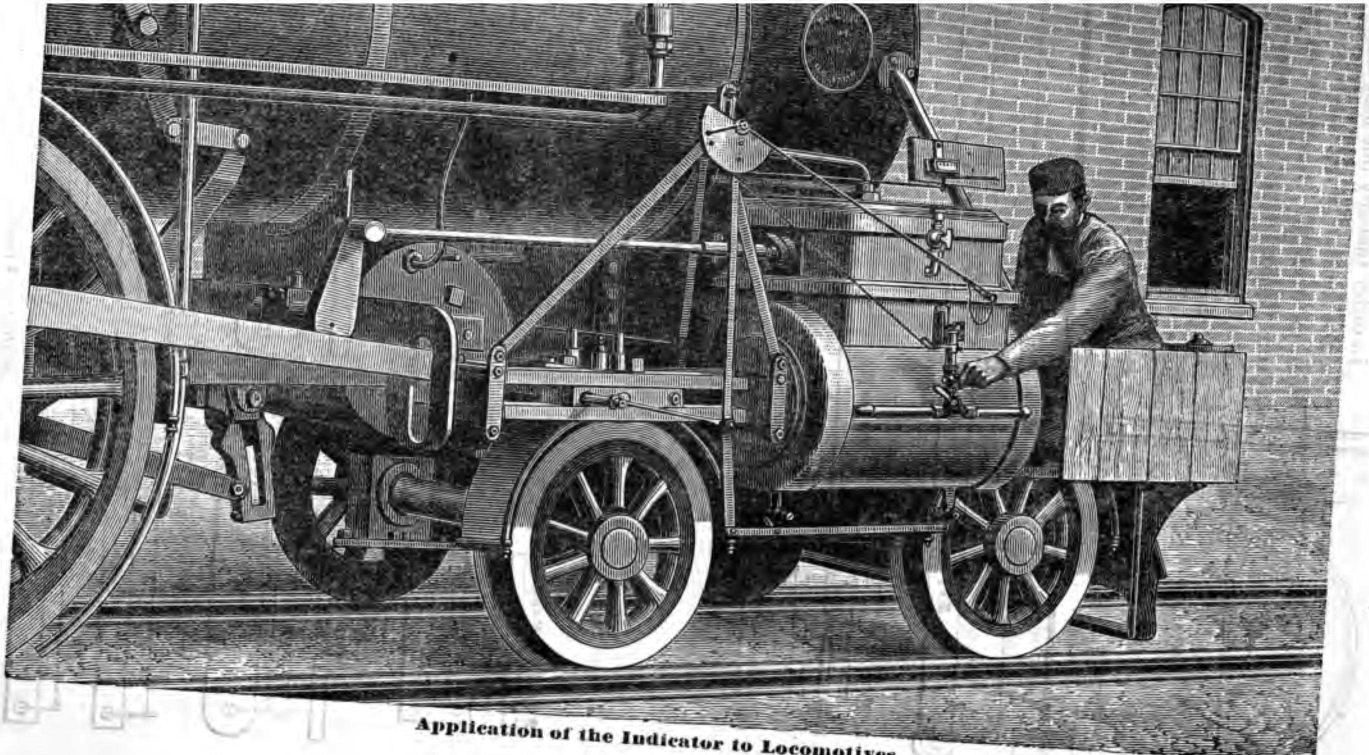
APPLICATION OF THE INDICATOR TO LOCOMOTIVES.

BY LEWIS F. LYNE.

During the past ten years the efficiency of stationary and marine steam engines has been increased fully 25 per cent., which fact can be truthfully attributed to the liberal use of the steam engine indicator. This little instrument has been called the engineer's

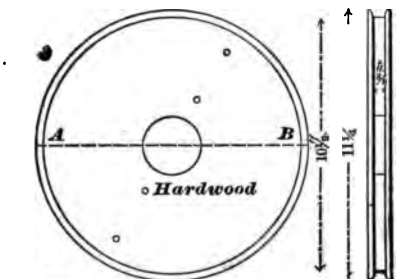
stethoscope, because it enables the engineer to see the action of the steam within the cylinder. The information thus obtained has greatly aided the builders of steam engines in correcting their proportions, and so successfully that the economy of their performance is in many instances remarkable. Why should not this apply to locomotives? It is very pleasing to know that upon some railroads the advantages of a free use of the indicator are greatly appreciated. There were never as many indicators in use as there are to-day, and I will assert that there would be more but for misrepresentation that has been sustained by unjust criticisms and too extravagant claims, all of which have tended to condemn its use. My principal object will be to explain some of the practical advantages and defects of the indicator, as well as its proper mechanical manipulation. I have been requested here to furnish something practical, and that is my intention.

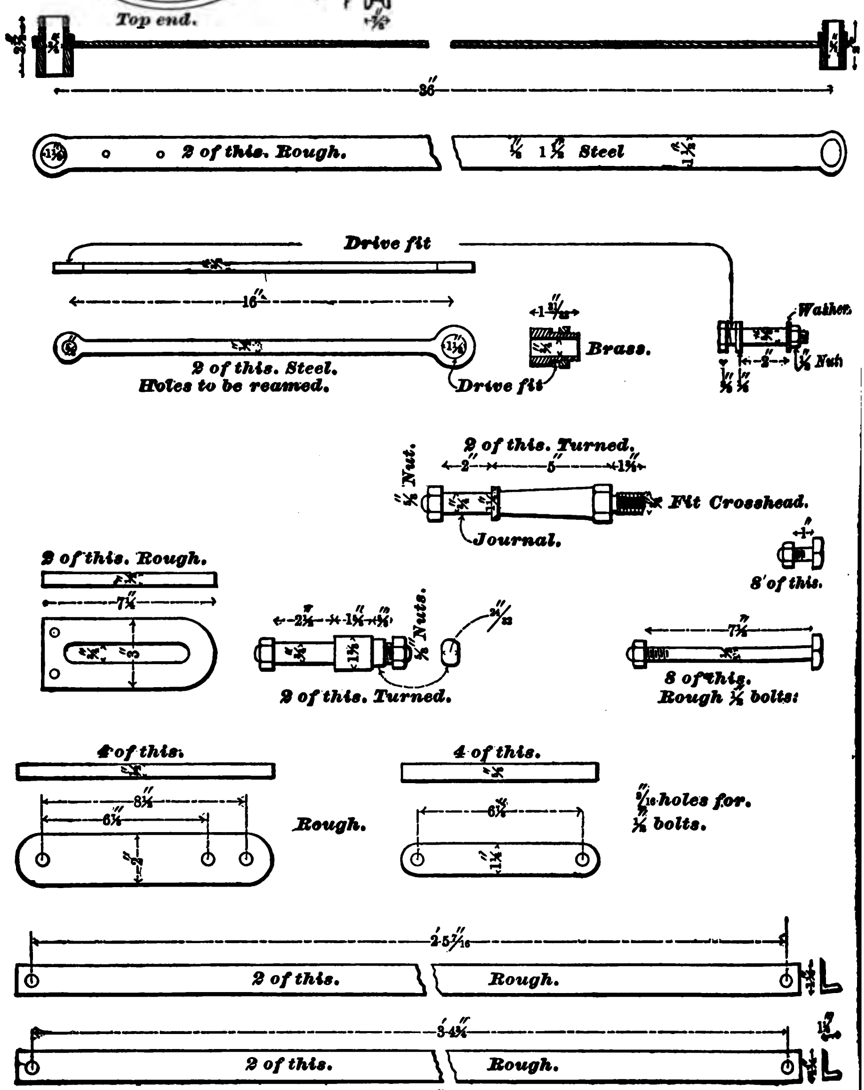
At the outset, let it be understood that there are a great many things which the indicator will not do, which fact seems to have been overlooked in a great measure. But there are a few things which can be revealed only by the indicator, from which the engineer can draw reliable conclusions as to the course he may safely pursue to improve the working conditions of his engines and machinery. A year ago I wrote an article on a "New Indicator Rig for Locomotives," giving dimensions of its parts. That rig, with a clearer method of attaching the indicators, is here represented by the large engravings with details.



Application of the Indicator to Locomotives.

In order that any one may make and use the mechanism for communicating motion from the cross head to paper drum, figured details are shown in the accompanying engraving, with sizes of each part marked in plain figures. The frame is composed of two pieces of $1\frac{1}{4}'' \times 1\frac{1}{4}''$ angle iron.





Scale $1\frac{1}{2}''$=1 foot.

These pieces of iron are of different lengths and have their lower ends bolted to clamps made of ½″x2″ bar iron held to the guides as shown in the engraving on page 243. The clamps upon the inside of the guides are of ⅝″x1¼″ iron, or whatever size will clear the piston gland and cross-head to answer for all the locomotives intended to be indicated.

The blocks placed between the outside of guides and clamps are of hard wood, of a proper length to bring the lever in line with the pitman. The top ends of the frame are bolted to a slotted plate of ½″x3″ iron. This plate is placed outside the frames, same as the clamps. The plate here shown is for locomotives having from 22″ to 24″ stroke. If a greater range is desired this plate must be longer and the frames shorter. The reason is that the upper end of the lever is suspended from a ¾″ pin fitting the slotted plate, and as the length of the stroke is shorter or longer this pin must be lowered or raised, to equalize the vibration of front end of the pitman above and below the center line of its motion. The lever is made of ⅛″x1½″ steel, having ends swollen out like eye bars to 1¾.″ The bushings are all of composition, made to drive fits in their places, and are helped by nuts as shown. The pitman is of steel, and is 16″ long between centers of bearings. Connection is made with the cross head by means of the stud shown for that purpose. An angle piece of light iron should always be bolted to the cross head to prevent lateral vibration of the lower end of the lever. The grooved arcs for the chord are made from cherry or other well-seasoned hard wood with a flat groove as shown.

A wheel should be turned up in a lathe of the shape shown; the hole in the center should fit the end of bushing in order to facilitate setting the same for bolting to the lever.

This wheel when finished, is to be sawed through the dotted line *A B*. The size here shown will take a diagram 3½″ long upon a locomotive having 24″ stroke. To prevent the frame from vibrating, a rod of half-inch iron, with an eye at one end, is attached to one of the bolts through the running board, while the other end is threaded 4″ from the end, and has a nut placed each side of the slotted plate at the top of the frame, as shown. The stud in the

cross head should be long enough to bring the grooved arc in line with the pulleys upon the indicator.

In applying this rig to a locomotive, place the cross head at half stroke, attach the frame to guides, and set the lever exactly at right angles to the guides and screw up all the nuts, being careful to spread the blocks so that the cross head will not strike them. All we now have to do is to adjust the lever vertically, which may be done in the following manner: With a pair of trammels set to the length of the lever, which in this case is 36″, describe an arc, and draw a straight line 24″ long, with the ends touching the arc. Measure from the center of the line to the arc, which in this case will be about 2″, and set the center of the lower pin in the lever half this distance below the center of the cross head, then tighten the nut on the upper pin. This will equalize the vibration, so that at the ends of the stroke the bottom end of the lever will be one inch above the center of cross head.

This laying out may, and should all be done beforehand, and the distance put down in a book for reference, so as to avoid delay. To prevent the chord from getting out of the groove, a wire loop should always be used, as shown. This rig, as will be seen, can be applied and adjusted without moving the engine. The indicator chord is very short, and the pitman connection quite long.

It has been asserted that this mechanical movement is defective, so I have decided to show some diagrams taken from it and from other movements, to enable you to discriminate intelligently as to their several merits. The movements which I am about to describe are frequently used by engineers for giving motion from the cross-head to the paper drum of the indicator. One of the most common of these movements is shown in fig. 2. It consists of a lever, *G*, suspended from the pin, *D*. From the centre of pin, *D*, to the centre line, *H*, of cross-head is 36 in. A grooved segment, *E*, for giving motion by a chord to the paper drum, is fastened to the end of the lever. The radius of this segment is sufficient to give the required length of diagram. This combination has been used for years by some prominent engineers, by whom it has been recommended. It is nevertheless one of the most erroneous motions for indicator purposes that has ever been used, as will appear presently. The length of this lever is constantly varying, and affects

the accuracy of the diagram, which errors are aggravated by a short lever. The longer the lever the less the errors. Hence a lever with a slotted end of eight or nine feet upon an engine having a stroke of 36 in. to 40 in. would work well enough in practice. The movements herein alluded to all have a lever 36 in. long and a stroke of 24 in. The diagrams are all full-sized, as they were taken.

Diagram I., fig. 6, was taken from a movement like that shown in fig. 2, which shows the precise relative position of the cross-head to the indicator pencil at each inch of the stroke. By setting a pair of dividers to, say, three middle divisions of the diagram and testing the ends of the diagram it will be found that the dividers cover 3⅜ divisions, or, in other words, when the cross-head will have traveled 2⅝ in. it will by scale measurement indicate 3 in. upon the diagram. This is a position where the greatest accuracy is required, especially in engines that cut-off short, and yet the greatest errors occur in using this motion within 3½ in. from the ends of the stroke. The reason for this will appear from the following test:

A fine Faber lead was placed in a hole through a thin strip of metal attached to the lever, so that it would describe the arc, *A B*, corresponding to a radius of 36 in. A piece of board was then attached to the cross-head in front of the pencil, and a piece of paper attached to the board. With a slight pressure the paper was brought in contact with the lead, and with one stroke of the cross-head the looped figure, fig. 1, was produced. This figure was drawn by placing the lever at *B*, then bringing the paper in contact with the lead and moving the cross-head toward *A*, the lead beginning at the upper left hand corner of the loop and moving downward toward *C*, as shown in fig. 1; thence it moves to *D*, where the lever assumes a vertical position. Passing on, the pencil follows the direction of the arrow bisecting the other line at *C*, and stopping at *B*, the cross-head having arrived at the end of the stroke. It will be observed that the end of the lever travels $\frac{5}{16}$ in. each side of the dotted centre line, *A*, which brings it that much short of the stroke at each end, or ⅝ in. less than the entire stroke. This shortens the diagram, as shown in fig. 6. When the cross-head arrives within 3½ in. of each end of the stroke, the lead will have

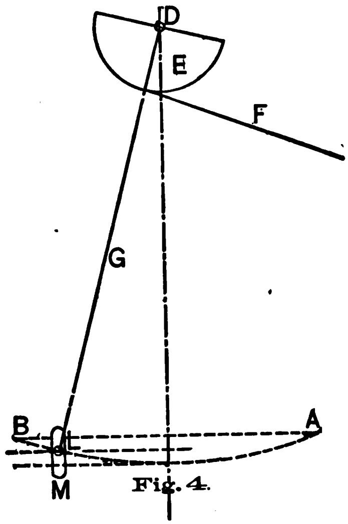


Fig. 4.

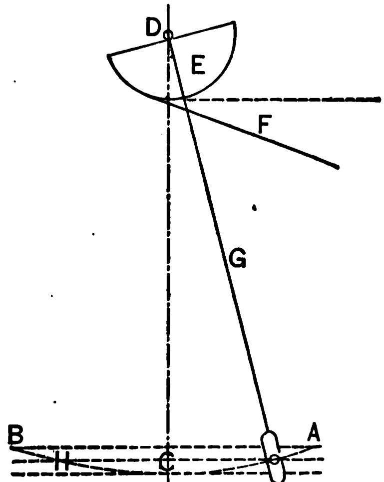


Fig. 2

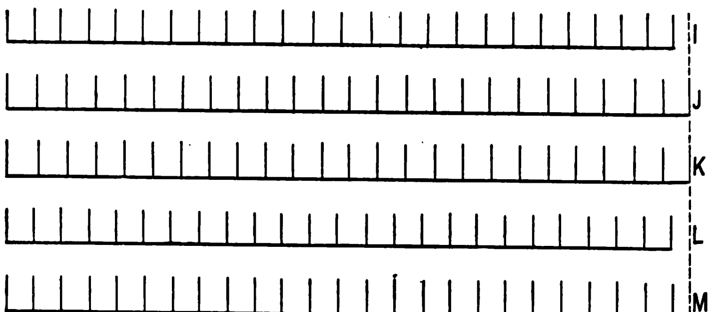


Fig. 6

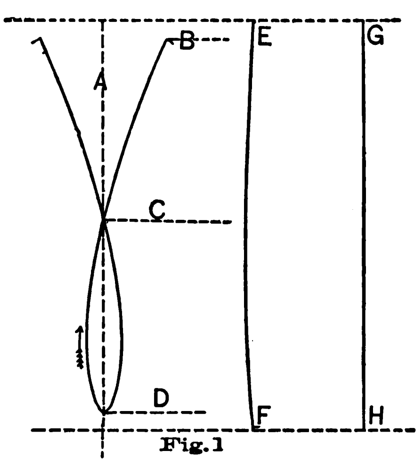


Fig. 1

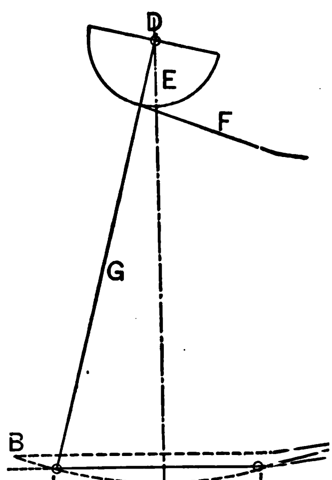


Fig. 3

ched *C*, which represents the centre line of cross-head. From
; point it moves off rapidly toward *B*, producing a sharp curve,
ich is due to the rapidly changing length of the lever. The
d, to make a correct movement, ought to follow the dotted line,
or nearly so. The reason why the spaces of the diagram, *I*,
unequal from the centre toward each end is now clear. Dia-
ım *J* exhibits the effect of using a pitman connecting the lower
l of the lever with the cross-head, as shown in fig. 3. This
man, *I J*, is 16 in. long, which is one-third the length of the
er, *G*. A fine lead was placed in the pin, *I*, which in one stroke
the cross-head drew the figure *F E*, fig. 1.

This curve has a radius of 16 in., the length of the pitman. Two
ps of very thin brass were used in the place of the indicator
d, *F*, shown in figs. 2 and 3, to overcome all errors due to the
etch of cord. A number of diagrams were taken to verify the
:uracy of the first. The dividers applied to diagram, *J*, will
eal slight errors in the last inch at each end, while the rest are
ıctically correct. These errors are due to the segment which
es a uniform velocity of cord at all parts of the stroke. It will
observed that this motion is the same as that shown in the large
graving, and the one that I advocate as the best I have ever
:d, which will be explained hereafter.

Diagram *K* was taken with a movement like that shown in fig. 4,
which a pin, *L*, was placed in the end of the lever, *G*, and
ves in a vertical guide, *M*, attached to the cross-head. A fine
ıd placed in the pin, *L*, drew the straight line, *G H*, fig. 1. It
ll be observed that the errors due to the slot and pitman connec-
ns with the end of the lever are thus entirely eliminated.

The faults discoverable by testing the diagram occur in the last
ch at each end, which is due to the segment as described and
e arc described by the lower end of the lever. Diagram *K* is
most identical with *J*. The motion shown in fig. 5 is like fig. 4,
th this exception: A pitman, *O*, 22 in. long was used instead
the segment, *E*, corresponding to a cord attached to a pin, *N*, in
e lever. A pitman was used to avoid the errors incident to
e use of a chord. With this motion Diagram *L*, fig. 6, was
en. By testing it will be found that this diagram is almost iden-
ıl with *I*, except that the spaces are nearer equal in the latter.

Diagram *M* was taken with a pitman 6 in. long instead of 22 in., being in a proper proportion to the other parts, and shows an improved spacing. This, in practice, would involve the use of a pulley, which ought always to be avoided if possible; furthermore, a cord will stretch much more when it runs over a pulley than when no pulleys are used. By using the rig shown in the large engraving the cord is made quite short, and when necessary two cords may be run from the segment to indicators placed one upon the cylinder as shown and the other upon the cock in the steam-chest.

If cords are attached to pins or screws in the lever, the error due to improper squaring of the pins with the direction of cord will be found greater than those due to the use of a segment. I have found this true in practice. The movements for reducing the motion of the cross-head and transmitting the same to the paper drum of the indicator are not, however, the place to look for the greatest errors. Fig. 7 shows the variations in lengths of diagrams taken at the various speeds marked upon the several lines. These lines were taken with an old style of indicator still much used upon slow-running engines. At 425 revolutions per minute the fling of the drum was so great that I was very much afraid that the cord would break, as it became quite slack before the spring could overcome the inertia of the rotating parts.

The diagram, fig. 8, was taken with the same kind of indicator and by the same maker, but with this change: A half-pound of weight had been removed from the rotating parts. The result becomes very apparent by a comparison of these two diagrams. Another source of error is the vertical movement of the pencil as shown in fig. 9. The scale, *A*, is 60 ℔s. to the square inch. An indicator with a 60 ℔. spring was attached to a steam drum with an accurate test gauge by the side of it. Steam was turned on and lines, *B*, were drawn at the several pressures marked upon them, advancing five pounds at a time from 0 up to 120 ℔s. per square inch. Steam was then turned off and the pressure allowed to fall gradually, and the lines, *C*, drawn as the pencil descended. It will be observed that the pencil lagged behind 2 ℔s. at the 115 ℔. line, 4 ℔s. at the 110 ℔. line, and when it reached the 110 ℔. line it was 5 ℔s. behind. This error continued until the pencil passed the 10 ℔. line, when it began to regain a portion of what it

had lost, so that when the pencil reached the 5 lb. line it was 3 lbs. behind, and at the 0 line it was behind 2½ lbs. If allowed to cool down the contraction of the spring will draw the pencil still lower, so that the error will be reduced still further. I have found a similar result repeatedly with indicator springs, and these errors are of such a nature that they would escape the observation of an engineer in indicating the engine in the usual way. Some of the manufacturers of indicators are getting their springs to scale very closely, but their strength is gradually changing, so that it is hardly safe to rely upon the springs without testing them. These diagrams are exhibited to show the fallacy of depending upon accurately graduated scales to measure indicator diagrams. Scales to be used for that purpose should be made directly from the instrument with the spring in place and under steam pressure in the manner described. Water or air pressure will not do, as the steam expands the spring, causing the pencil to change its position. You may readily see that a person attempting to figure the actual horse-power of an engine from diagrams taken with the spring used in making fig. 9 would show an excess of power. By the graduated sc le, the pencil rose to 134 lbs., whereas by the test gauge it is shown to be only 120 lbs. Here is a discrepancy at once of 14 lbs., which would make a great difference upon a quick running engine. Furthermore, the spaces made by the lines are not equal. Test scales should always be taken from the springs both before and after the test, as spiral springs often take a permanent set, sometimes amounting to several pounds. The test diagram, fig. 9, shows an example of this character. By use the spring gradually gets weaker, until it finally breaks. Its life may be stated as a certain number of vibrations.

With all its faults I recommend a free use of the indicator, especially upon locomotives, not for the purpose of getting the actual horse-power, water consumption, or theoretical performance, but for the following reasons: To show the distribution of the steam in the cylinders, also wire-drawing in the passages, in consequence of their being too small. It will also show the improper setting of valves, for resistance, if there be too much or too little "compression," and the amount of back pressure. All of these matters are of importance in the economical working of locomotives.

The evaporation of locomotive boilers can be quite accurately arrived at by placing a Worthington water metre in the tank, to measure the water, and weighing the coal. I consider this the most reliable way. Whenever a locomotive gets to working badly and without any apparent reason, an application of the indicator will generally reveal the defect. When disease makes its appearance it should have a proper diagnosis before the prescription is made up. In the large engraving it is seen that I use a pull-up arrangement for the cord, instead of hooking on, a somewhat difficult process when a locomotive is running fast and a great waste of valuable time. The cord is attached to the indicator drum, passes into the groove of the segment upon the lever and out of the side as shown. Thence it passes through a screw-eye in the end of the stud bolt through the top of the lever, and the end secured to a screw or pin in the edge of a cylinder by means of a loop. To start the indicator drum, pull up the cord and slip the loop over the screw. To stop the drum slip the loop off the screw and drop it. The end of the cord should be tied to the screw to facilitate picking up the loop. There is no practical difference in the length of the cards, owing to the stretch when the best braided linen cord is used. The Silver Lake people, of Boston, make a very excellent cord, which is free from stretch and is water-proof. The cylinders of locomotives should be tapped when they are in the shop and a ¾ inch nipple and elbow screwed into each end, as shown. By removing the plugs from the elbows the indicator pipes and other rigging may be attached; I have repeatedly completed the whole operation in one hour.

To make this work profitable for railroad companies, a bright young man should be selected, furnished with the necessary apparatus, and an accurate record kept of all his work. Much time and money are wasted because of a lack of records of slight changes made in valves and valve motion. Every master mechanic who has made a practice of indicating the locomotives placed in his charge to find out their defects will testify that it pays. Our late Vice-President, Howard Fry, was one of that class of persons.

On motion the paper was ordered to be received and embodied in the proceedings of the Association.

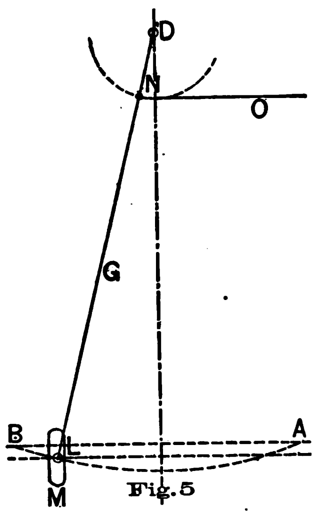


Fig. 5

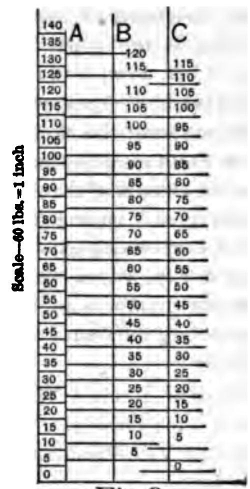


Fig. 9

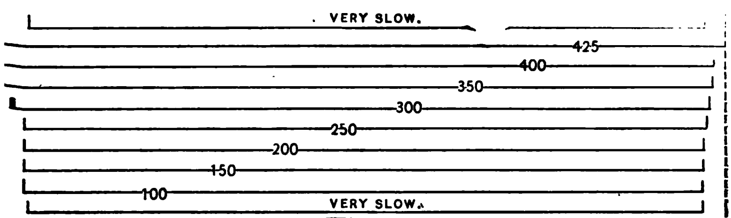


Fig. 7

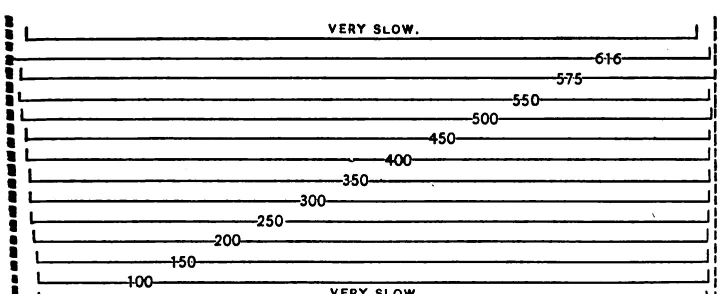


Fig. 8

MR. ROSS, who seconded Mr. Sprague's former motion, consented to its withdrawal.

Mr. Sprague's subsequent motion was not seconded.

MR. JOHANN—I positively say that I am not a candidate for any office, and I shall not accept it. I am not here for any office; I am here to assist in the reports and deliberations of the Association, and any labor that I perform is a labor of love. I move that we proceed to the election of President. I wish to say that on several occasions, because some officer has been elected by acclamation, it has been agreed that the other officers should be elected by acclamation; and I suggest that we adopt the rule now of going into an election by balloting for every officer.

MR. ROSS—I believe that our constitution calls for the election of officers by ballot. I therefore move to amend that Tellers be appointed and that we proceed at once to ballot. Agreed to.

The President appointed Mr. George B. Ross, and Mr. W. L. Short as Tellers.

The members then proceeded to ballot for President. The Secretary announced that the total number of votes cast was 46, of which Reuben Wells received 43 and James Sedgley 3.

MR. SEDGLEY, Vice-President—Reuben Wells having a majority of the votes cast, is elected President.

MR. WELLS—Gentlemen, I was in hopes that you would elect some one else, my worthy friend on the left, Mr. Sedgley, for instance. But as you have seen proper to honor me with an election for the second term, I of course desire to express my sincere thanks for the confidence you have had in me, and for the compliment you have paid me by your action; and I will promise to endeavor to discharge the duties of the office to the best of my ability. [Applause.]

The next business will be the election of First Vice-President.

The Committee then proceeded to ballot for First Vice-President. The Secretary announced that the total number of votes cast was 36, 35 of which were cast for James Sedgley.

THE PRESIDENT—I therefore have the pleasure of announcing that Mr. James Sedgley is elected First Vice-President of this Association for the next year. [Applause.]

MR. SEDGLEY—Gentlemen of the Convention, permit me to express my sincere thanks for this compliment. Had my feelings been consulted, I should much prefer that you had elected another man for my place; but since you have elected me to the office, I will try to serve you to the best of my ability. [Applause.]

proper for me to explain, that would prevent me from serving the organization as I could wish, and I hope that none of my friends will seek to elect me.

MR. FLYNN—Thanking my friend for the honor which he wishes to confer on me—also being one of the old gray heads—I must respectfully beg leave to decline. It is true we commenced wrong at first. For a number of years we continued the same officers in power. Now we have got down to a point which is correct and right. We elect our officers for one year, and then honor them by re-election. It is then understood they step down and out, and others take their place. I am anxious for the re-election of our worthy President. Then when this year passes, he steps down and out, and our First Vice-President takes his place, knowing the fact that his service will be for two years. Then some of our old gray headed men who are anxious to fill their positions can come in. A great many of us who are gray headed, with God's help, have a great many years before us, if not carried off by sickness. If we live to the Scriptural limit, some of us have twenty years, some fifteen, most of us fifteen, and in that fifteen years we may reach the position filled by our present worthy President. Thanking again my worthy friend for his nomination, I beg leave to decline it at the present time. I do not say what I may do when I get older. [Applause.]

MR. JOHANN—I simply wish to remark that the proper mode of electing officers to my notion would be to expedite the business by allowing the Committee to present the names of such members as are able to be voted upon. I think we are all well satisfied that large bodies move slowly and are hard to control, and I am sure that this is not a society for the purpose of educating Presidents, altogether. We may not do our business exactly in a parliamentary way, but we do it in our own way, and generally do it to our satisfation. I do not agree with our friend Mr. Sprague, that the President should be renewed each year. I believe that whenever we have a good executive officer, it is proper to keep him there for some time. I do not think that any officer can get the full measure of his duties in one term. It generally takes him one term to learn what he has to do, and then the second term he can carry it out. I would as lief elect a President for an indefinite time if he is a good executive officer. I think the proper way for us to do is to refer the matter to a committee to present names to the convention, and when this committee acts on it and presents the names, I for one say, let us all join in and elect those persons.

MR. SPRAGUE—I only want to get this thing fixed down to some definite rule. I withdraw my former motion, and I will now move that the committee's report be amended by adding the names of Mr. Flynn and Mr. Johann for Second Vice-President.

MR. ROSS, who seconded Mr. Sprague's former motion, consented to its withdrawal.

Mr. Sprague's subsequent motion was not seconded.

MR. JOHANN—I positively say that I am not a candidate for any office, and I shall not accept it. I am not here for any office; I am here to assist in the reports and deliberations of the Association, and any labor that I perform is a labor of love. I move that we proceed to the election of President. I wish to say that on several occasions, because some officer has been elected by acclamation, it has been agreed that the other officers should be elected by acclamation; and I suggest that we adopt the rule now of going into an election by balloting for every officer.

MR. ROSS—I believe that our constitution calls for the election of officers by ballot. I therefore move to amend that Tellers be appointed and that we proceed at once to ballot. Agreed to.

The President appointed Mr. George B. Ross, and Mr. W. L. Short as Tellers.

The members then proceeded to ballot for President. The Secretary announced that the total number of votes cast was 46, of which Reuben Wells received 43 and James Sedgley 3.

MR. SEDGLEY, Vice-President—Reuben Wells having a majority of the votes cast, is elected President.

MR. WELLS—Gentlemen, I was in hopes that you would elect some one else, my worthy friend on the left, Mr. Sedgley, for instance. But as you have seen proper to honor me with an election for the second term, I of course desire to express my sincere thanks for the confidence you have had in me, and for the compliment you have paid me by your action; and I will promise to endeavor to discharge the duties of the office to the best of my ability. [Applause.]

The next business will be the election of First Vice-President.

The Committee then proceeded to ballot for First Vice-President. The Secretary announced that the total number of votes cast was 36, 35 of which were cast for James Sedgley.

THE PRESIDENT—I therefore have the pleasure of announcing that Mr. James Sedgley is elected First Vice-President of this Association for the next year. [Applause.]

MR. SEDGLEY—Gentlemen of the Convention, permit me to express my sincere thanks for this compliment. Had my feelings been consulted, I should much prefer that you had elected another man for my place; but since you have elected me to the office, I will try to serve you to the best of my ability. [Applause.]

THE PRESIDENT—The next business in order will be the election of Second Vice-President.

A MEMBER—I wish to say that I am going to vote for Mr. Flynn, and I hope others will join me in doing so.

MR. FLYNN—I thank the gentleman for his kindness, but I maintain the position that I have taken. I will not serve. It is a matter of honor with me. I am a member of the Nominating Committee, and if elected I could not properly accept the office.

The Convention then balloted for Second Vice-President. The Secretary announced that the whole number of votes cast was 34, of which J. D. Barnett received 14, J. H. Flynn 9, F. M. Wilder 5, R. H. Briggs 5; blank, 1.

THE PRESIDENT—There being no election, you will please prepare your ballots again. It requires a majority of all the votes cast to elect.

MR. FLYNN—Being next to the lowest on the vote there, I withdraw from the race.

The Convention then balloted again for Second Vice-President. The Secretary announced that the total number of votes cast was 37, of which J. D. Barnett had received 17, J. H. Flynn 7, F. M. Wilder 3, and R. H. Briggs 10.

THE PRESIDENT—Gentlemen, there being no election, you will proceed to ballot again.

MR. FLYNN—I sincerely trust Mr. President that those who have been kind enough to cast votes for me will select some one else, especially as the room is rather warm, and it is not very pleasant sitting in here; and we will get through our business sooner.

The Convention then balloted again for Second Vice-President. The Secretary announced that the total number of votes cast was 42, of which J. D. Barnett had received 22, J. H. Flynn 13, F. M. Wilder 3, and R. H. Briggs 4.

THE PRESIDENT—You have heard the result of the ballot. I therefore declare Mr. J. D. Barnett elected Second Vice-President for one year.

MR. BARNETT—Mr. President and Gentlemen, when you elected me to this position before, I was absent, and had not the pleasure of thanking you; and I am sorry to say that at the time of the next annual convention I was in England, and could not be present with you. I hope during the succeeding year that what little duties fall upon the Second Vice-President will be fully performed, and anything I can do to help this Association shall be done readily; personally, and on behalf of the country which I will say, unfortunately, does not float the Stars and Stripes, I have to thank you for my election.

THE PRESIDENT—The next business before you will be the election of Treasurer. I believe there is but one in nomination, Mr. Richards. You will now prepare your ballots.

The Convention then balloted for Treasurer. The Secretary announced that the whole number of votes cast was 36, of which George Richards had received 32, W. M. Foster 2, James Sedgley 1, and blank one.

THE PRESIDENT—I have the pleasure of declaring that Mr. George Richards is elected Treasurer of this Association. [Applause.]

MR. RICHARDS—Mr. President and Gentlemen, seeking no office, I have to thank you for the honor you have done me in electing me Treasurer. I will endeavor to perform the duties of that office faithfully.

THE PRESIDENT—The next business will be the election of Secretary. You will please now prepare your ballots.

A MEMBER—If it be constitutional, I move that the President be authorized to cast the vote of the Convenion for Secretary.

MR. SETCHEL—I would much prefer that the election should be by ballot.

The Convention then proceeded to ballot for Secretary.

THE PRESIDENT—The result of the ballot for Secretary is as follows: Whole number of votes cast 36, of which J. H. Setchel received 34, J. Johann 1, and blank 1. I therefore declare that Mr. Setchel is elected Secretary of the Association. According to our Constitution, the term of one of the Committeemen of the Standing Committee on Subjects expires with the present meeting, and that is the term of James Boone, and it will be necessary to elect some one to take his place or re-elect him.

MR. FLYNN—I nominate Mr. Boone for that position.

A MEMBER—I nominate Mr. Short.

A MEMBER—I nominate Mr. McCrum.

The Convention then balloted for member of Committee on Subjects. The Secretary announced that the total number of votes cast was 36, of which Mr. Boone had received 19, Mr. Short 14, and Mr. McCrum 3.

THE PRESIDENT—I therefore declare Mr. Boone elected as Committeeman for three years.

MR. BLACK—I move that the salary of the Secretary be the same as it was for the past year. Agreed to.

THE PRESIDENT—There is a report due from the Committee to select a place for our next annual meeting, and also from the Committee on Subjects. I would ask if that Committee is ready to report?

The Committee on Subjects presented the following report:

To The American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee appointed to select subjects for discussion of the next annual meeting, respectfully beg leave to report the following:

1. Improvement in Boiler Construction.
2. New Plans of Construction and Improvement in Locomotives.
3. Smoke-stacks and Spark Arresters.
4. Shop Tools and Machinery.
5. Best Material for Construction of Locomotives, Truck and Tender Wheels.
6. Best Practical Mode of Educating Locomotive Engineers.
7. Balanced Valves.
8. Lubrication of Valves and Cylinders.

JAMES BOONE,
JOHN H. FLYNN,
GEORGE RICHARDS. } *Committee.*

F. G. BROWNELL—I would like to make an addition to that—a Committee on the coneing of the tread of wheels.

Carried.

The Committee on Resolutions presented the following report:

CHICAGO, June 21st, 1883.

GENTLEMEN—Your Committee on Resolutions beg leave to present the following:

Resolved, That the thanks of this Association are due and are hereby tendered to the Rev. F. M. Bristol; Mayor Harrison, of Chicago; the Committee on Entertainment; the Illinois Central Railroad; the press of Chicago; the proprietors of the Grand Pacific Hotel and the Executive Committee of the Exposition, for favors and attentions which greatly contributed to the success of the meeting and the enjoyment of the members.

JACOB JOHANN,
GEORGE B. ROSS,
THOMAS B. TWOMBLEY. } *Committee.*

The report was received.

The Committee presented the following report, recommending Saratoga, as the place of meeting.

MR. SETCHEL—I beg leave to add to the report of the Committee on the place for holding our next meeting—Long Branch. I think that would be a preferable place for the reason that the meeting of the car builders takes place in Saratoga, and we have already had an example of what it is to keep a committee of entertainment on duty for two or three weeks. The men are worn out and their families are tired of it.

MR. ROSS—As Chairman of that Committee, I would accept the addition to the report.

MR. SETCHEL—I move that this matter be decided by a standing vote. I propose Long Branch as the place of meeting.

Long Branch as a place of meeting received twenty-nine votes. A vote being taken as to Saratoga, two votes were cast in favor of that place.

THE PRESIDENT—Long Branch has been selected as the place for holding our next meeting.

On motion of Mr. Sprague, the Convention then adjourned.

[MITTEES AND SUBJECTS FOR DISCUSSION AT THE SEVENTEENTH ANNUAL MEETING.

1.

ovement in Boiler Construction.

J. JOHANN, W. & St. L. R. R.,
WILLIAM FULLER, N. Y., P. & O. R. R.,
G. H. PRESCOTT, T. H. & I. R. R.,
J. DAVIS BARNETT, Midland R'y,
S. D. BRADLEY, G. R. & I. R. R.

2.

Plans of Construction and Improvements in Locomotives.

W. WOODCOCK, C. R. R. of N. J.,
AMOS PILLSBURY, E. R. R., Mass.,
DANIEL WEAVER, C. & O. S. W.

3.

ke Stacks and Spark Arresters.

R. H. BRIGGS, M. & O. R R.,
JOHN HEWITT, Mo. P. R. R.,
JOHN ORTTON, N. Y. C. R. R.,
H. D. GORDON, P., W. & B. R R.,
GEO. W. STEVENS, L. S. & M. S.,
H. M. SMITH, St. L., B. & T. R. R.,
W. L. GILMORE, C., C., C. & I. R. R.

4.

Tools and Machinery.

H. N. SPRAGUE, H. K. Porter & Co.,
JOHN BLACK, C., H. & D. R. R.,
J. K. TAYLOR, O. C. R. R.

5.

Material for Locomotive Truck and Tender Wheels.

CHAS. H. CORY, Boston & Hoosac T. R. R.,
R. C. BLACKALL, D. & H. C. Co. R. R.,
J. B. ROSS, N. Y., L. E. & W. R. R.

6.

Practical Method of Educating Engineers.

JOHN H. FLYNN, W. & A. R. R.,
J. N. LAUDER, O. C. R. R.,
C. K. DOMVILLE, Gt. W. of Can.

7.

Balanced Slide Valves.

JAMES MEEHAN, C., N. O. & T. P. R. R.,
AMOS WATTS, K. C. R. R.,
T. L. CHAPMAN, C. & O. R. R.

8.

Best Method and Material for Lubricating Valves and Cylinders.

HENRY SCHLACKS, I. C. R. R.,
JAMES BOON, C. N. W. R. R.,
HARVEY MIDDLETON, St. P., M. & M. R. R.

9.

Coneing of the Tread of Wheels.

F. G. BROWNELL, B. & S. R. R.,
J. M. FOSS, C. V. R. R.,
A. G. EASTMAN, S. E. R. R.

10.

Associate Members to Read Papers at the next Annual Meeting.

ANGUS SINCLAIR, American Machinist,
WILLARD A. SMITH, Chicago Review.

11.

Trustees Boston Fund.

REUBEN WELLS,
JAMES SEDGLEY,
J. DAVIS BARNETT,
J. H. SETCHEL,
GEO. RICHARDS.

12.

Committee of Arrangements for the Seventeenth Annual Meeting.

W. WOODCOCK, Central R. R. N. J.,
H. D. GARRETT, Penn. R. R.,
F. M. WILDER, N. Y., L. E. & W. R. R.

CONSTITUTION.

As Amended at the Fourteenth Annual Meeting, Providence, June 14, 1881.

PREAMBLE.

We, the undersigned Railway Master Mechanics, believe that the interests of the Companies by whom we are employed, may be advanced by the organization of an association which shall enable us to exchange information upon the many important questions connected with our business. To this end do we establish the following

CONSTITUTION.

ARTICLE I.

SECTION 1. The name and style of this Association shall be the AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

ARTICLE II.

SEC. 1. The officers of the Association shall be a President, a First and Second Vice-President, a Secretary, and a Treasurer.

SEC. 2. The above-named officers shall be elected separately, by ballot, at each Annual Convention, and a majority of all votes cast shall be necessary to a choice.

SEC. 3. Two Tellers shall be appointed by the President to conduct the election and report the result.

ARTICLE III.

SEC. 1. It shall be the duty of the President to preside in the usual manner at all the meetings of the Association, and approve all bills against the Association for payment by the Treasurer.

SEC. 2. It shall be the duty of the Vice-Presidents, according to rank, to perform the duties of the President in his absence from the meetings of the Association.

SEC. 3. In case of the absence of both President and Vice-Presidents, the members present shall elect a President *pro tempore*.

SEC. 4. It shall be the duty of the Secretary to keep a full and correct record of all transactions at the meetings of the Association; to keep a

record of the names and places of residence of all members of the Association, and the name of the road they each represent; to receive and keep an account of all money paid to the Association, and at the close of each meeting deliver the same to the Treasurer, taking his receipt for the amount; to receive from the Treasurer all paid bills, giving him a receipted statement of the same.

SEC. 5. It shall be the duty of the Treasurer to receive all money from the Secretary belonging to the Association; to receive all bills against the Association, and pay the same, after having the approval of the President; to deliver all paid bills to the Secretary at the close of each meeting, taking a receipted statement of the same; to keep an accurate book account of all transactions pertaining to his office.

ARTICLE IV.

SEC. 1. The following persons may become members of the Association by signing the Constitution, or authorizing the President or Secretary of the Association to sign for them, and pay the initiation fee of one dollar: Any persons having charge of the Mechanical Department of a Railway known as "Superintendents," or "Master Mechanics," or "General Foremen," the names of the latter being presented by their superior officers for membership, also two Mechanical Engineers, or the representative of each Locomotive Establishment in America.

SEC. 2. Civil and Mechanical Engineers, and others whose qualifications and experience might be valuable to the Association, may become Associate Members by being recommended by three Active Members. Their names shall then be referred to a committee, which shall report to the Association on their fitness for such membership. Applicants to be elected by ballot at any regular meeting of the Association, and five dissenting votes shall reject. The number of Associate Members shall not exceed twenty. Associate Members shall be entitled to all the privileges of active members excepting that of voting.

SEC. 3. Any person who has been or may be duly qualified, and signs, or causes to be signed, the Constitution, as member of the Association, remains as such until his resignation may be voluntarily tendered.

SEC. 4. All members of the Association will be liable for such dues as may be necessary to assess to defray the expenses of the Association, and any member who shall be two years in arrears for annual dues shall have his name stricken from the roll, and be duly notified of the same by the Secretary.

ARTICLE V.

SEC. 1. The Regular meeting of the Association shall be held annually on the third Tuesday in June.

SEC. 2. Regular meetings shall be held at such place as may be determined upon by a majority of the members present at the previous meeting.

SEC. 3. An adjourned meeting may be held at any time and place that a majority of the members present at any meeting may elect.

SEC. 4. The regular hours of sessions shall be from 9 o'clock A. M to 2 o'clock P. M.

SEC. 5. During the business sessions no communications shall be received or acted-upon other than those pertaining to the business of the Association.

SEC. 6. At this, the Thirteenth Annual Meeting, the President shall appoint three members to constitute a standing committee to recommend to the Association at each Annual Meeting subjects for discussion at each succeeding Convention, one member for three years, one for two years, and one for one year, designating the term of each member, and each succeeding year one member of said committee shall be elected by the Association by ballot.

The said committee shall, at one o'clock on the second day of each Annual Convention, report to the Association subjects for discussion at the succeeding Convention.

At 7:30 o'clock of the second day of each Annual Convention there shall be a joint meeting of said committee with an advisory committee, composed of the officers of the Association, which joint committee shall, at ten o'clock on the morning of the third day of each Annual Convention, nominate to the Association the members of the several committees upon said subjects. Said joint committee shall nominate, upon subjects which require reports, from various parts of the country, full committees of three or five, which committees shall be called committees of research, and shall have power to solicit reports from not all but a part of the members of the Association upon such subjects; and upon other subjects said joint committee shall nominate simply the chairman of the committees, who shall have power to select their own associates upon such committees, which shall be called committees of investigation: said joint committee shall also nominate two Associate Members to read papers at the succeeding Annual Meeting.

All committees so appointed, whether of research or investigation, shall meet at four o'clock on the afternoon of the third day of each Annual Convention to plan and divide its work for the ensuing year.

Each committee on research shall, on or before the first day of July of each year, send to the Secretary of the Association a circular letter setting forth the character of reports desired from the members, together with a list of persons to whom said letter shall be sent; and the Secretary

shall immediately print and mail the same to such members, with an earnest request that, as a matter of courtesy, full replies thereto shall be sent on or before the first day of April following to the chairman of such committees.

Each committee, whether of research or of investigation, shall, if possible, meet pursuant to the call of its chairman, during the second week in April of each year, for the preparation of its report, which, in the absence of such meeting, shall be prepared by the chairman, and shall immediately forward the same to the Secretary of the Association, by whom it shall be printed and supplied to the members at the commencement of each Annual Convention.

Each report of such committees shall name the members of the Association from whom replies to said circular letters were requested but not received, on or before the first of April as aforesaid.

ARTICLE VI.

SEC. 1. This Constitution may be amended at any regular meeting of the Association by two-thirds vote of the members present.

Resolution Passed at the Sixth Annual Meeting, Baltimore, Maryland, May, 1873.

Resolved, That no expense shall be incurred by committees except by the unanimous consent of the General Supervisory Committee, given in writing to the Chairman of said Committee, stating the amount to be expended.

Resolution on Boston Fund, Passed at the Eighth Annual Meeting, New York, May, 1875.

Resolved, That the Boston Fund, amounting now, with accrued interest, to $3,620, be invested in Government securities to be selected by the duly appointed Trustees, and not to be disturbed for the purpose of expenditure unless authorized by the majority of members present in open Convention, and then only after due notice of a motion to expend the same has been given at the session immediately preceding; and that the interest accumulating shall every year be invested in the same manner as the principal, and a full account of the same be duly reported with other financial statements.

Resolution Adopted at the Ninth Annual Meeting.

Resolved, That members of the Association who have been in good standing for a period of not less than five years and who through age or other cause cease to be actively engaged in the mechanical departments of railroad service, may, upon the unanimous vote of the Association, be elected "Honorary Members," who shall have their dues remitted and be entitled to all the privileges of regular members except that of voting.

ORDER OF BUSINESS.

1. Reading the Minutes of the previous meeting.
2. Calling the Roll of Members.
3. Signing the Constitution.
4. Report of Secretary.
5. Report of Treasurer.
6. Report of Committees appointed at a previous meeting.
7. Election of Officers.
8. Appointment of a Committee to suggest Subjects for Consideration.
9. Appointment of Miscellaneous Committees; Finance, Printing, and Place of Holding Next Annual Meeting.
10. Report of Committee to suggest Subjects for Consideration.
11. Appointment of Committees to report upon Subjects suggested for Consideration.
12. Unfinished Business.

R. WELLS,
JAMES SEDGLEY,
J. DAVIS BARNETT, *Committee.*
GEO. RICHARDS,
J. H SETCHEL,

LIST NAMES AND ADDRESS OF MEMBERS.

NAME.	ROAD.	ADDRESS.
Anderson, H.,	204 Dearborn Street,	Chicago, Ill.
Anderson, J. H.,	N. Y. B. & P.,	Providence, R. I.
Arden, D. D.,	C. & S. W. of Ga.,	Savannah, Ga.
Anderson, E. D.,	Ill. Cent.,	Macomb City, Miss.
Barton, J. C.,	H. & C. W.,	Hartford, Conn.
Bryan, H. S.,	C. & I.,	Aurora, Ill.
Britton, H. M.,	R. W. & O.,	Oswego, N. Y.
Boon, J. M.,	C. & N. W.,	Chicago, Ill.
Bushnell, R. W.,	B. C. R. & N.,	Cedar Rapids, Ia.
Brastow, L. C.,	C. R. R. of N. J.,	Wilkesbarre, Pa.
Boyden, G. E.,	95 Oliver Street,	Boston, Mass.
Brooks, H. G.,	Brooks Locomotive Works,	Dunkirk, N. Y.
Barnett, J. Davis,	Midland R. R.,	Port Hope, Ont.
Black, John,	C. H. & D.,	Lima, Ohio.
Blackall, R. C.,	D. & H. C. Co.,	Albany, N. Y.
Bissett, John,	C. & E.,	Florence, S. C.
Briggs, R. H.,	C. O. & S. W.,	Elizabethtown, Ky.
Bradley, S. D.,	G. R. & I.,	Grand Rapids, Mich.
Brigham, L. L.,	Passumpsic,	Lyndonville, Vt.
Brownell, F .,	P. & S.,	Burlington, Vt.
Berry, L. D.,	D. M. O. & S.,	Oseola, Iowa.
Brokaw, W. I.,	D. & R. G.,	Salt Lake City, Utah.
Bothwell, James,	C. & N. W.,	Baraboo, Wis.
Brooks, L. R.	Lima Iron Works,	Birmingham, Ala.
Blackwell, Chas.,	N. W. & S. V.,	Roanoke, Va.
Cullen, James,	N. & C.,	Nashville, Tenn.
Campbell, E. A.,	N. Y. T. & M.,	Victoria, Texas.
Campbell, John,	L. V.,	Delano, Pa.
Colby, G. H.,	B. & A.,	Boston, Mass.
Cascaddin, R. O.,	C. R. I. & P.,	Trenton, Mo.
Chapman, N. E.,	Midvale Steel Co.,	Philadelphia, Pa.
Chapman, J. W.,	N. Y. L. E. & W.,	Hornellsville, N. Y.
Chapman, Thos. L.,	C. & O.,	Richmond, Va.
Cummings, S. M.,		Boston, Mass.

NAME.	ROAD.	ADDRESS.
Coolidge, G. A.,	Fitchburg,	Charlestown, Mass.
Clark, David,	L. V.,	Hazleton, Pa.
Clark, Peter,	Northern,	Toronto, Canada.
Cooper, H. L.,	L. E. & W.,	Lafayette, Ind.
Cook, James,	Danforth & Cook's L. W.,	Patterson, N. J.
Cushing, George,	N. P.,	St. Paul, Minn.
Crockett, John F.,	B. L. & N.,	Boston, Mass.
Cory, Chas. H.,	B. H. T. & W.,	Saratoga, N. Y.
Colburn, Richard,		Norwich, Conn.
Clifford, J. G.,	L. & N.,	Bowling Green, Ky.
Cook, John S.,	Georgia,	Augusta, Ga.
Cook, Allen,	C. & E. I.,	Danville, Ill.
Dotterer, S. H.,	D. & H. C. Co.,	Carbondale, Pa.
Donaldson, A.,	O. & M.,	Vincennes, Ind.
Davis, N. L.,	R. & V.,	Rutland, Vt.
Devine, J. F.,	W. & W.,	Wilmington, N. C.
Dripps, W. A.,	3224 Walnut Street,	Philadelphia, Pa.
Durgin, J. A.,		Providence, R. I.
Domville, C. K.,	G. W. of Canada,	Hamilton, Canada.
Downe, George,	Government R. R.,	Sidney, Australia.
Evans, Edward,	C. W. & B.,	Chilicothe, Ohio.
Ellis, Matthew,	C. St. P. M. & O.,	Saint Paul, Minn.
Eddy, H. W.,	Boston & Albany,	Springfield, Mass.
Eblen, James,	L. R. & Ft. S.,	Argenta, Ark.
Elliott, Henry,		East St. Louis, Ill.
Ellis, J. C.,	Schenectady Loco. W'ks.	Schenectady, N. Y.
Ellis, W. H.,	P. & R. Railroad,	Catawissa, Pa.
Eckford, James,	N. Y. C. & St. L.,	Bellevue, Ohio.
Eastman, A. G.,	S. E.,	Richford, Vt.
Ennis, W. C.,	N. Y. S. & W.,	Wortendyke, N. J.
Foss, J. M.,	C. V.,	St. Albans, Vt.
Flynn, J. H.,	W. & A.,	Atlanta, Ga.
Fuller, William,	N. Y. P. & O.,	Cleveland, O.
Finlay, L.,		Little Rock, Ark.
Foster, W. A.,	W. & M. Div. F. R. R.,	Fitchburgh, Mass.
Ferguson, Geo. A.,	B. C. & M.,	Lake Village, N. H.

NAME.	ROAD.	ADDRESS.
ates, G. W.,	Western of N. C.,	Salisbury, N. C.
arrett, H. D.,	P.,	Philadelphia, Pa.
riggs, Albert,	P. & W.,	Providence, R. I.
ordon, H. D.,	P. W. & B.,	Wilmington, Del.
raham, Charles,	L. & B.,	Kingston, Pa.
ilson, D. Gregg,	Capiopa,	Chili, S. A.
ordon, James P.,	Concord,	Concord, N. H.
raham, J. S.,	L. S. & M. S.,	Buffalo, N. Y.
ilmore, W. L.,	C. C. C. & I.,	Cleveland, O.
eorge, Nathan M.,	D. & W.,	Danbury, Conn.
arding, B. R.,	R. & G.,	Raleigh, N, C.
ollister, Jas. D.,	S. F. & W.,	Savannah, Ga.
am, C. T.,	Buffalo Steam Gauge Co.,	Rochester, N. Y.
ewitt, John,	M. P.,	St. Louis, Mo.
all Sen. Don Diago,	Supt. Loco. Dep't F. C.	Santiago, Chili, S. A.
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lackney, C.,	A. T. & S. F.,	Topeka, Kan.
lowison, N. W.,	C. & R.,	Mt. Savage, Md.
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lenney, J. B.,	W. C.,	Stevens Point, Wis.
lowe, Geo. E.,	St. J. & L. C.,	St. Johnsbury, Vt.
latswell, T. J.,	F. & P. M.,	East Saginaw, Mich.
lovey, J. P.,	R. & P.,	Rochester N. Y.
lorniblower, J. P.,	Government,	Queensland, Australia
lall, J. W.,	L. & N.,	Montgomery, Ala.
lickey, John,	M. L. S. & W.,	Manitowoc, Wis.
lofecker, W. L.,	P. & W.,	Pittsburgh, Pa.
nness, Thos. B.,	115 Broadway,	New York City.
vanson, John,		Cincinnati, O.
ohnson, J. B.,	N. C.,	Helena, Ark.
ohann, Jacob,	W. & St. L.,	Springfield, Ill.
effery, E. T.,	I. C.,	Chicago, Ill.
acques, Richard,	Capiopa,	Chili, S. A.
ielmer, John T.,	P. & A.,	812 E. York st., Phila.

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IN MEMORIAM.

Samuel J. Hayes.

The death from consumption of Samuel Jarvis Hayes which occured at his residence in Chicago on the morning of Sept. 21st, 1882, closed a long and active career, and removed one of the pioneers in the field of railway mechanical engineering.

Mr. Hayes was one of the first members of this association having held the position of Treasurer since its organization, and was, at the time of his death Superintendent of Machinery of the Illinois Central Railroad, having held this position 26 years.

He was born near Powhattan factory, four miles from Baltimore, Oct. 9th, 1816, and was at the time of his death nearly 66 years old.

Left fatherless when four years of age, he was compelled two years later to enter a cotton mill where he continued at work for 11 years.

At the age of 17 he became an apprentice in the shops of Gillingham & Winans at Mount Clare, Baltimore, who were then engaged building and repairing engines for the Baltimore & Ohio Railroad.

In 1837 when the Baltimore & Ohio Railroad took control of the shops, Mr. Hayes entered the service of that Company where he remained for 19 years.

Three months after completing his apprenticeship he was appointed gang foreman, and at the age of 23 was promoted to shop foreman, having also charge of the engines running on that portion of the line.

Shortly after this, one of the engines under his charge was fired up without water in the boiler, and the crown burnt. Being held responsible for this mishap he lost his position, and leaving Baltimore, moved to Winchester, Virginia.

The company evidently regretting this hasty action, soon recalled Mr. Hayes, and he again entered the service as Master Mechanic, which position he held until 1852, when he was promoted to the position of Master of Machinery having full charge of all the rolling stock and shops on the road.

The Illinois Central Railroad which had begun operations in 1854 with wood burning engines, found it necessary to adopt coal as fuel. In looking about for a skilled mechanic competent to make the necessary changes, their choice fell upon Mr. Hayes who accepted the task, entering into the service of the Illinois Central Company, Aug. 26, 1856.

He completed this work with characteristic energy and judgment, and continued to administer the affairs of the machinery department until the time of his death, retaining the respect and confidence of his superiors and associates to the last.

Mr. Hayes' combined mechanical skill with sound judgment in its application. His retentive memory was a storehouse of actual experiences. He remembered minutely the construction of successive locomotives, from the first one built for the Baltimore & Ohio Railroad to the engine of to-day. His experience had taught him caution and he was slow to adopt new devices, often confounding the sanguine advocate of some brilliant invention with the recital of a trial and failure of the same device many years before. But although his long experience made him cautious and conservative, it also gave him great confidence in the application of any idea which met with his approbation.

He was amiable in personal character, beloved and respected by his subordinates who served him zealously, and still look back with pleasure to their connection with him, grateful alike for his kindly personal interest and the thorough training his strict intelligent discipline afforded them.

His remarkable vigor was undiminished to the last. He gave his undivided attention to the affairs of his department until within two months of his death.

His widow, Mrs. Martha E. Hayes, whom he married in Baltimore, Sept. 1839, and a daughter, survive him.

E. T. JEFFERY.

John Edington Martin.

John Edington Martin, a young but bright and shining light, has been taken from among us, and we are left to mourn a loss that cannot be replaced.

John E. Martin was the oldest of eleven children. His father James Martin, a native of Aberdeen, Scotland, was a mechanical engineer of marked ability. Coming to this country in 1850, when only 22 years old, he finished his practical education in the Rogers Locomotive Works at Paterson, New Jersey. He was then in service for eleven years as Locomotive Superintendent on the Northern and Grand Trunk Railway in Canada, then for a short time in Buenos Ayres erecting bridges, and for the last six years of his life as Locomotive Superintendent of the Northern Railway of Chili, S. A., where he died in 1871 at the age of 43; his son John, the subject of the present memoir, was born at Paterson, New Jersey, October 28, 1852. He spent the first 12 years of his life in Canada, where he laid the foundation of his education at school, and under the careful training of his father, who having a mind given to investigation, soon learned his son the importance of knowing the reasons for everything that turned up in applied mechanics.

The son having an active mind, drank in the precepts and example of the father, and after having spent a year at school in England, went with his father to Chili in 1865. There he got two years more of schooling, and at the early age of 15 his father took him into the shops to teach him the practical part of mechanical engineering. He had already acquired considerable proficiency as a draughtsman, and had competed successfully at school for prizes in right line drawings with young men of age and much greater experience. The writer has a number of his drawings which show care, accuracy, and skill.

While in the shops of the Northern Railway of Chili, where his father was Locomotive Superintendent, he soon showed great aptitude for the profession his father had selected for him. His industry, cleverness, and sterling character soon won for him the good

will of all who met him; he was the idol of the mother, the loved brother of the other children, and the pet of the father, who always saw beaming in his eyes, unswerving fidelity to truth, honor and honesty. The father soon learned to know that his son was truth itself, and besides this, he was rapidly showing signs of real genius; the father had told him, that as soon as he was old enough he was going to send him to the United States for a higher and more complete education. The boy recollected this, and when in 1871 stern, unrelenting death swept the spirit of the father from this earth at the early age of 43, he, the son, was not content until he had carried out the wishes of the father. Providing himself with a letter of introduction to the writer (who has had a long experience with railways in Spanish America), he came to New York in 1873, presented his letter and expressed a wish to be taken into some leading railway or locomotive works, where he was willing to render good service for the information he would obtain of American practice in mechanical engineering.

The writer who had never seen him before, was at once struck with the modest gentlemanly manner, the bright eye, and the flashing intelligence of the handsome young Scotch laddie, and said: "Of course I will assist you, for I see at a glance that you are worthy of all any one can do for you."

A situation such as he desired was procured for him in the Baldwin Locomotive Works, where he soon won the esteem of the proprietors, and the good will and friendship of all others by his industry, ability, and gentlemanly deportment; from those great works he was admitted into the extensive works of the Pennsylvania Railway at Altoona, then, as now, considered to be the most complete and systematic railway works in America, if not in the world. There, with his active brain, he soon grasped everything that was to be learned, and with well filled note-books and neatly made sketches (duplicates of all which he made for the writer), he returned to the Baldwin Works and after a further service there, he was received at the Rogers Locomotive Works at Paterson, where his father had served before him, and where he was born.

While at Paterson, he, like elsewhere, soon became a favorite with all, and was taken into the confidence and especial patronage

of that eminent engineer and locomotive constructor, Wm. S. Hudson, Superintendent of those works. He was not slow to perceive that he was in the hands of a great master of the art he longed to be a proficient in. He reveled in the valuable information he received every day from the master; it was seed sown on rich ground, for it took root and lived in the store-house of his memory. He told the writer that it was meat and drink to him to hear Mr. Hudson talk.

Time slipped away, months followed months, but none were thrown away. The boy became a man; it now became important that he should buckle on the armor of knowledge that he had been polishing and making stronger every day, and begin to fight his own way in the world. Securing good letters from all those he had served with, and from the writer, who had many powerful friends in Spanish America, he returned to Chili, where his father had made for himself a name, and where he had spent some of the early and happy years of his life; presenting his letters to officers of the Government, and being backed by a bright and intelligent look, that assisted him everywhere, he was at once appointed Locomotive Superintendent of the Chillan, Concepcion & Talcahuana Railway, it being the Southern Division of the Great Southern Railway of Chili; his zeal, industry, and intelligence soon won for him the good will and unbounded confidence of the Railway Commissioners, who allowed him to make some valuable experiments on the powers of locomotives, as connected with economy of fuel. Among these experiments were a series requiring no small amount of skill, daring, and courage; erecting a tent over one of the cylinders of a locomotive, he sat in it and took many Indicator Diagrams (while running at 20 to 40 miles an hour) under different conditions of lap, lead, clearance and travel of valves, steam pressure, expansion, &c., while rounding curves and climbing gradients with light and heavy loads; the results of a part of these experiments were given to your association in a well written paper, and published in your proceedings in 1877.

Continuing his experiments and investigations in locomotive economy and railway progress for some years more, and giving great satisfaction to the Railway Commissioners who granted him every facility, he was rapidly acquiring fame and a name in the

world of Railway Mechanical Science, when he met with a serious check.

The health of the Railway Comissioner failed and he was obliged to retire; a new Commissioner was appointed, who, wishing to absorb all authority in his own person, and make others assume the responsibility of his own errors, soon disgusted Martin, who being high strung, as men of his intelligence generally are, and not being willing to bow down to conceit and ignorance, resigned his position and retired from Government employ, rather than sacrifice his ideas of right, and become the mere tool of a man who owed his position to some family influence, or political accident.

Martin soon obtained a very prominent position as Locomotive Superintendent of the Mollendo, Areguipa & Puėro Railway in Peru, one of the great Trans-Andean Railways that crosses the main range of the Cordilleras at an elevation exceeding 14,000 feet abovė the sea (in fact, on this line we had over 70 miles that exceeded 14,000 feet elevation).

On taking charge of this post, Martin found himself again under the direction of a General Manager, a man utterly ignorant of all railway knowledge, filled with conceit, and unable to brook any authority in any one but himself. Martin soon saw that Areguipa (the hot-bed and nursery of all revolutions in Peru) was no place for him, so he returned to Chili after visiting the Nitrate regions of Tarapaca, and making himself acquainted with the various methods used in the manufacture of this, a great and growing industry, the Nitrate of Soda, the substance that has excited the cupidity of the whole West coast, and occasioned the long and bloody war between Chili and Peru.

Having left the employ of Chili under circumstances that were never fairly and properly understood or presented to the government, Martin was unable to again find employment on Government Works, and there being at the time no other works requiring such talent as he could render, he became disheartened; his proud spirit sunk suddenly under the blow that had been struck by ignorance at his independence and authority, and on the 4th day of November, 1882, he died at the close of his 30th year, and so passed away a spirit in the prime of life, a spirit that during life embodied all that belonged to a good son, a loving brother, a bright

youth, a clever engineer, an amiable gentleman, and an honest man. He and all his accomplishments now lie sunk in the silence of the grave by the side of his father, their graves being in the shadow of a tall shaft of Aberdeen Granite cut from the eternal hills where the father first saw light, and erected by loving friends.

Surely,

"Man is of few days, and full of trouble, and he cometh forth like a flower, and is cut down."

W. W. EVANS.

MEMOIR

—OF—

HOWARD FRY.

On the night following the 26th of April last, Howard Fry, who was one of the most esteemed members of this Association, was so seriously injured near Bellevue, Michigan, while traveling in a sleeping car, on the Chicago & Grand Trunk Railroad, that he died soon after. The train was stopped at an unusual place, near the foot of a heavy grade, by the bursting of a brake hose-pipe. A following freight train ran into the rear end of the standing passenger train, owing to the neglect of a brakeman to go back far enough to stop the freight train in time to prevent a collision. Our associate and friend was taken from the wreck still alive and conscious, but so seriously injured that he died in a few hours.

He was born at Plymduth in Devonshire, England, January 6th, 1846. He was the fourth son of Edmund and Caroline Mary Fry. He received his early education with his brothers, at home, from his mother, who devoted herself very closely to her children's education, being relieved from other household cares by a sister-in-law who resided with them.

His father left Plymduth and came to London in 1848, and for many years was associated with Elihu Burritt in opposing war and advocating, by lectures and other means, the cause of universal peace. His family at this time resided at Upper Norwood, then a quiet village. His father's income being but limited, his mother's

cares and anxieties with her large family were great and made a powerful impression upon him.

At the age of ten years he was sent to join his three elder brothers at the Friends' School at Libford near Baubury. Here he received a good plain English education. He was also for a short time at a private school.

At the age of fourteen, he entered the shops of the South Eastern Railway at Ashford as an apprentice. After finishing his apprenticeship, he was made assistant foreman and locomotive inspector at the shop at Bricklayer's Arms in London. While under Mr. Cudworth he was employed part of the time in making experiments in the combustion of coal in locomotives, which no doubt had much to do with directing his attention to this subject afterwards. Among the devices experimented with was Cudworth's fire-box, with a long and steeply inclined grate, in the efficiency of which Mr. Fry always felt great confidence, and when engaged on the Erie Railway afterward, he built a boiler in which this form of grate and fire-box were to be used, but before it could be tried he left the employ of the company, and his successors were not imbued with the same faith in it that he had, and it was abandoned.

In March 1867, he came to Canada and was appointed Locomotive Inspector on the Grand Trunk road. He remained in that position until January 1st, 1868, when he was appointed Assistant Mechanical Superintendent of the Eastern Division. In 1873, when Mr. Watson was President of the Erie Railway Company, he made inquiries for a competent person for the position of superintendent of motive power for that road. Mr. Fry was recommended for the place, and Mr. Watson soon after appointed him with the title of Supervisor of Locomotives, under Mr. Henry Tyson, who was fourth Vice President and in charge of the machinery department of that line. The difficulties and the complications encountered by Mr. Watson in the administration of the affairs of the unfortunate Erie Company, led to his own and Mr. Tyson's retirement. The latter seemed to open a chance for promotion to Mr. Fry, and there was good reason for his expecting that he would get the appointment of Superintendent of Machinery, if he was considered competent for the place. Unfortunately, when Mr. Watson's successor came into office, Mr. Fry, from motives of delicacy,

did not urge his own claims, and no friend acted in his behalf and another applicant was appointed to the place. It was said that when the matter was brought to the attention of the authority that made the new appointment, he seemed unaware that there was such a person as Mr. Fry in the employ of the Company, or that he was a person of exceptional ability and unquestionable integrity.

It was a great disappointment to poor Fry. It seemed to him as though at the very threshold of success he had failed, and as though the judgment of his ability, which was thus rendered by those above him, was that he was incompetent for the place he aspired to. There was then no other course left to him but to resign his position, which he did. As soon as the facts became known regarding his relations to the Erie Company, some of his friends secured for him the appointment of Superintendent of Motive Power and Machinery on the Philadelphia and Erie Division of the Pennsylvania Railroad, with his office at Williamsport, Pa., where he went in 1874. He remained there until September, 1881, when the position of Superintendent of Motive Power and Machinery of the New York, West Shore & Buffalo Railroad was offered to him, which he accepted. This gave him an opportunity and opened a career to him which few men in his occupation ever have. It was a new road to extend from New York to Buffalo, for which he was appointed to design the rolling stock, the shops, and all the equipment. The purpose of the managers was to have this done in the very best manner. It was and is intended to be a main line alongside the New York Central Railroad, and to compete with the older road. No expense, nor ability, nor ingenuity which the new road could command was to be spared to make it attractive and complete in every respect. How hard, how ably, and how faithfully the subject of this memoir worked to accomplish the work intrusted to him probably only those who were closely associated with him know.

Mr. Fry had in a wonderful degree the capacity for investigating all subjects submitted for his judgment. With the most enduring patience and energy he would collect all the data relating to a subject, and, as it were, hold his mind in reserve until he had collected all the available material on which to form an opinion and base his conclusions. He was not a remarkably ingenious man, nor was he

a very skillful designer of mechanism, but he had, what was perhaps much more valuable to his employers, a judicial mechanical mind. He would listen and give heed to both sides of a question, and weigh all the arguments for and against a given course, and then cutting loose from tradition and prejudice and engineering cant—for there is such a thing—he would form his conclusions from the evidence before him. He was singularly without prejudice and pride of opinion, although he would urge his own views with great vigor when he thought that they were sustained by sound reasons and indubitable facts, and was tenacious of his own conclusions when he was convinced they were right.

He took great interest in his occupation and its duties, and he regarded it not merely as a means to the end of money-getting, but he took pride in his work in the broad sense that to do it faithfully and to advance the general knowledge of it helped to make the world a more desirable place to live in, and its occupants more comfortable and happy. He was always ready to entertain suggestions which indicated in any way how railroad accidents could be prevented, or which would make the occupations of railroad employes less dangerous. He was one of the most ardent advocates of the use of the block system of running trains. That he should have been taken away by an accident which that system would have prevented is inexpressively sad. His life was an example of a man who sought success, yet subordinated his efforts to achieve it to the fixed purpose of retaining his integrity, and who never even allowed the bloom to be brushed from his character, nor the fragrance of his reputation to be sullied. His memory will always inspire those who knew him well with faith in what is right and true, and of hope in the future of mankind, if, as he showed, men, under the ordinary circumstances of life, may still live as nobly as he did.

MATTHIAS N. FORNEY.

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REPORT OF PROCEEDINGS

OF THE

SEVENTEENTH ANNUAL CONVENTION

OF THE

AMERICAN RAILWAY

Master Mechanics' Association,

IN CONVENTION

AT THE OCEAN HOTEL,

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AMERICAN
Railway Master Mechanics' Association.

OFFICERS FOR 1884-85.

President,

JOHN H. FLYNN, OF ATLANTA, GA.

First Vice-President,

J. DAVIS BARNETT, OF PORT HOPE, ONT.

Second Vice-President,

WILLIAM WOODCOCK, OF ELIZABETHPORT, N. J.

Treasurer,

GEORGE RICHARDS, OF BOSTON, MASS.

Secretary,

J. H. SETCHEL, OF CINCINNATI, O.

REPORT.

The Seventeenth Annual Convention of the American Railway Master Mechanics' Association was held in the Ocean Hotel, Long Branch, N. J., June 17th, 18th and 19th, 1884.

The Convention was called to order by President Reuben Wells, of Louisville, Ky., who introduced the Rev. Frederick T. Brown, of Long Branch, who invoked the Divine blessing as follows:

Reverend and Eternal God, Creator of the heavens and the earth, we hail Thee as the Architect, the Designer, the Master Mechanic of the universe. We believe that Thou hast designed all things, that Thou hast made all things, that Thou dost rule and govern all things; we believe that as Thou didst give skill and wisdom to Bezaleel in the wilderness, to Midium in Jerusalem, to work in gold and in silver, in precious stones, in scarlet and fine linen, in the cedar wood from Lebanon, to do things for the Ark and for the Tabernacle, and for Thy Holy Temple, according to Thy purpose, that so Thou dost give skill and wisdom to those that have the direction of the affairs of men on the earth in all ages.

We believe that all wisdom and skill in art and in mechanics, in society, in the development, and in the carrying forward of this world in its career of progress, in railroads, in steamships, in electric telegraphs, in locomotives, in all these things that are so closely related with the material prosperity of the earth, Lord God, we believe that Thou art in it all. We believe that these that have designed so widely and have executed so skillfully, have produced works that are marvels in our eyes, have received that skill and that wisdom from Thee. We would lift up our hearts, then, to Thee this day, to give Thee hearty thanks for everything. We would bow the knee before Thee, Thou King Eternal. We would ac-

knowledge our dependence upon Thee. We would submit our ways to Thee.

O Lord, we thank Thee for what has been done, we thank Thee for the gigantic strides that have been made in all departments of mechanical art. We thank Thee for the exceeding skill that hath been manifested. We thank Thee for what has been done to make this world brighter and better, to bring its distant parts near together; and now, Lord, we thank Thee for the goodness that hath brought together these skilled workmen, these skilled co-workers. We thank Thee that Thou hast watched over them, that Thou hast been with them as they have journeyed hither, with their friends that hath accompanied them.

We pray Thee to be with them in their deliberations, give them wisdom in all that they shall discuss, and in all that they shall conclude. We pray Thee, give them a spirit to love knowledge, to love the truth, to love the things that shall be, not for personal adornment or honor, but for the best good of the people of these United States.

We commit them to Thee. Guard them against temptation, guard them against sin, guard them against harm, while they are here, and then in Thy good Providence carry every one of them safely to their homes.

O Lord, be with him who shall preside over the assembly. Be with those that are associated with him. Give them discretion and wisdom, and crown all their acts with success.

And so may we have acceptance before Thee to-day, and every day, and always, through our Lord, Jesus Christ. Amen.

THE PRESIDENT—

Gentlemen—I now have the pleasure of introducing to you the Rev. E. D. Tompkins, who will entertain us with a short address of welcome.

MR. TOMPKINS—

Mr. President and Gentlemen of the Association—The Committee having the matter in charge did me the honor to ask me to represent the citizens of Long Branch in welcoming your Association here. Among the many advantages which you will have by meeting at Long Branch, there is one very great disadvantage, which is, that your address of welcome has to be made, not by a Mayor, but

by a Minister. Nevertheless, I count it a real privilege and honor that I am asked to welcome your Association, and I say this not in any poor way of compliment. I think we shall all agree that the older we grow and the more we think, the more it seems to us —at least it does to me—that the only real division that ought to be made between all men that live, is the division between the workers and the drones—between the men that pay their way through life by contributions of brain and hand-skill, and the men who live on those contributions and play their way through life.

I do not know as much about your Association as I wish I did, nor as much as I intend and hope to know before your sessions are concluded; but I know enough about it to welcome you in the name of my fellow-citizens to our town. Your Association represents the workers of the world, the men who are in at the heart of things and down at the roots of things. I never ride in a railway train without thinking of the silent man off on the engine who has everything under his control. And so we go on through life hanging on to some silent men—for they are more apt to be silent, I think, than others, they do not make as much noise and fuss in the world as some. And so, with a very real sense of the privilege conferred upon me, I bid you welcome to Long Branch.

The report of your Convention last year was handed to me this morning, and I turned to the address of welcome made to the Association at Chicago by Mayor Harrison, and I was overwhelmed because I found that the Mayor had taken up the bulk of his address in telling you about the wonderful things you would see in Chicago. You were there, I believe, at the time of the Exposition, and there was a great deal to be seen, but you will see one thing here that Chicago can not boast of, and that is, Old Ocean. It does seem to me that there is in the sight of Old Ocean—and I hope there will be for you—an elevating, uplifting, broadening power that ought to tell on your discussions here. We who live in sight of it all the time have grown accustomed to it. I fully remember when I first saw the Falls of Niagara, that the feeling came over me how any man could gaze upon that great sight without being inspired with the wonderful beauties of God's work. Ministers, you know, are apt to fall to moralizing. I wondered how

men could be other than good and liberal within sound of all that grandeur. Yet I never found men who haggled so for twenty-five cents as the men who lived within sound of the roar of that great cataract. So it is possible to live at Long Branch and yet be mean, but it does seem to me that for people who do not live here, who have come here to sit down and talk together by the sea, there ought to come from that wonderful sight a power of inspiration and of uplifting. May it be so for you.

Gentlemen, I welcome you to Long Branch. May your visit be a source of profit to you in this Association, and may your stay be so pleasant that you will come again soon and come often. [Applause.]

THE PRESIDENT—The first business will be the calling of the roll. Members will please answer as their names are called.

SECRETARY—Mr. President, 49 members have answered to their names.

LIST OF MEMBERS PRESENT.

NAME	ROAD.	ADDRESS.
ANDERSON, H.	204 Dearborn St	Chicago, Ill.
ANDERSON, J. H.	New York, Boston & Providence	Providence, R. I.
BRITTON, H. M.	Rome, Watertown & Ogdensburg	Oswego, N. Y.
BUSHNELL, R. W.	Burlington, Cedar Rapids & Northern.	Cedar Rapids, Iowa.
BOYDEN, G. E.	New York & New England	Boston, Mass.
BARNETTE, J. DAVIS	Midland	Port Hope, Ont.
BLACK, JOHN	Cincinnati, Hamilton & Dayton	Lima, Ohio.
BLACKALL, R. C.	Delaware & Hudson Canal Co	Albany, N. Y.
BRADLEY, S. D.	Grand Rapids & Indianapolis	Grand Rapids, Mich.
BRIGHAM, L. L.	Passumpsic	Lyndonville, Vt.
BROWNELL, F. G.	Burlington & Lamoille	Burlington, Vt.
BERRY, L. D.	DesMoines, Osceola & Southron	Osceola, Iowa.
BLACKWELL, CHAS	Norfolk & Western	Roanoke, Va.
CAMPBELL, JOHN	Lehigh Valley	Delano, Pa.
COLBY, G. H.	Boston & Albany	Boston, Mass.
CHAPMAN, N. E.	Midvale Steel Co., 833 Walnut St.,	Philadelphia, Pa.
COOLIDGE, G. A.	Fitchburg	Charlestown, Mass.
CLARK, DAVID	Lehigh Valley	Hazleton, Pa.
COOPER, H. L.	Lake Erie & Western	Lafayette, Ind.
CORY, CHARLES H.	Boston, Hoosac Tunnel & Western	Saratoga, N. Y.
COOK, JOHN S.	Georgia	Augusta, Ga
COOK, ALLEN	Chicago & Eastern Illinois	Chicago, Ill.
DEVINE, J. F.	Wilmington & Weldon	Wilmington, Del.
DRIPPS, W. A.	No. 3224 Walnut St	Philadelphia, Pa.

LIST OF MEMBERS PRESENT.

NAME.	ROAD.	ADDRESS.
DURGIN, J. A.	34 Pine Street	New York.
EDDY, W. H.	Boston & Albany	Springfield, Mass.
EASTMAN, A. G.	South Eastern of Canada	Richford, Vt.
ENNIS, W. C.	New York, Susquehanna & Western	Wortendyke, N. J.
FLYNN, J. H.	Western & Atlantic	Atlanta, Ga.
FULLER, WILLIAM	New York, Pennsylvania & Ohio	Cleveland, Ohio.
FINLY, L.		Little Rock, Ark.
FOSTER, W. A.	Fitchburg	Fitchburg, Mass.
FERGUSON, GEO. A.	Boston, Concord & Montreal	Lake Village, N. H.
GATES, G. W.	Western of North Carolina	Salisbury, N. C.
GRIGGS, ALBERT	Providence & Worcester	Providence, R. I.
GORDON, H. D.	Philadelphia, Wilmington & Baltimore.	Wilmington, Del.
GRAHAM, CHARLES	Lackawanna & Bloomsburg	Kingston, Pa.
GORDON, JAMES T.	Concord	Concord, N. H.
HARDING, B. R.	Raleigh & Gaston	Raleigh, N. C.
HEWITT, JOHN	Missouri Pacific	St. Louis, Mo.
HODGEMAN, S. A.		Wilmington, Del.
HACKNEY, GEO.	Atchison, Topeka & Santa Fe	Topeka, Kas.
HATSWELL, T. J.	Flint & Pere Marquette	East Saginaw, Mich.
HOVEY, J. P.	Rochester and Pittsburg	Rochester, N. Y.
JOHANN, JACOB	Wabash & St. Louis	Springfield, Ill.
LAUDER, J. N.	Old Colony	Boston, Mass.
McGLENN, JAMES	Carolina Central	Laurinsburg, S. C.
MORRELL, J. E.	Chicago, Rock Island & Pacific	Davenport, Iowa.
PRINGLE, R. M.	St. Louis & Cairo	St. Louis, Mo.
PRESCOTT, G. W.	Texas & St. Louis	St. Louis, Mo.
PRESCOTT, G. H.	Terre Haute & Indiana	Terre Haute, Ind.
PILLSBURY, AMOS	Eastern	Boston, Mass.
RICHARD, GEO.	Boston & Providence	Boston, Mass.
REYNOLDS, G. W.	Old Colony	Taunton, Mass.
ROSS, GEO. B.	New York, Lake Erie & Western	Buffalo, N. Y.
ROBERTS, E. M.	Ashland Coal and Iron Co	Ashland, Ky.
STOKES, J. W.	Ohio & Mississippi	Pana, Ill.
SMITH, W. T.	Erie & Pittsburg	Erie, Pa.
STRODE, JAMES	Northern Central	Elmira, N. Y.
SETCHEL, J. H.	Ohio & Mississippi	Cincinnati, Ohio.
SPRAGUE, H. N.	H. K. Porter & Co	Pittsburg, Pa.
SITTON, B. J.	Selma, Rome & Dalton	Selma, Ala.
SWANSTON, WILLIAM	Jeffersonville, Madison & Indianapolis.	Indianapolis, Ind.
TWOMBLY, F. M.	Old Colony	Taunton, Mass.
TANDY, H.	Canada Locomotive Works	Kingston, Ont.
TWOMBLY, T. B.	Chicago, Rock Island & Pacific	Chicago, Ill.
TURREFF, W. F.	Cleveland, Columbus, Cincinnati & Indianapolis.	Cleveland, Ohio.
THOMAS, W. H.	Chesapeake & Ohio	Huntington, W. Va.
WELLS, REUBEN	Louisville & Nashville	Louisville, Ky.
WIGGINS, J. E.	Sabine Pass & Texas Northern	Marshall, Tex.
WOODCOCK, WILLIAM	Central of New Jersey	Elizabethport, N. J.
WILDER, F. M.	New York, Lake Erie & Western	Susquehanna, Pa.

LIST OF MEMBERS PRESENT.

NAME.	ROAD.	ADDRESS.
WIGHTMAN, D. A.	Pittsburg Locomotive Works	Pittsburg, Pa.
WARREN, W. B.	Indianapolis, Bloomington & Western	Indianapolis, Ind.
FORNY, N. M.	73 Broadway	New York City.
MILES, F. B.		Philadelphia, Pa.
WELLARD A. SMITH	Chicago Review	Chicago, Ill.
SINCLAIR, ANGUS	96 Fulton St	New York City.
DRIPPS, ISAAC	3405 Walnut St	Philadelphia, Pa.

THE PRESIDENT—For the information of any who may be desirous of joining our Association, I will ask the Secretary to read Article 4 of the Constitution.

Mr. Setchel, the Secretary, read the article referred to, and moved that a recess of five minutes be taken to enable persons qualified and wishing to become members, to sign the Constitution. Carried.

Upon the Convention being called to order, the President delivered his annual address:

Gentlemen of the American Railway Master Mechanics' Association:

It gives me great pleasure at this, the opening of our Seventeenth Annual Convention, to see so large a number of members in attendance from the various parts of the United States, and from our neighbor, the Dominion of Canada.

I congratulate you this morning on the favorable auspices of this meeting, and trust it may be the most profitable and interesting of any that we have heretofore held. Our membership is larger than ever before. Our finances are in good condition, as the reports of the Secretary and Treasurer will show, and I believe I may safely say that the Association has, to a greater extent than ever before, the hearty support and good will of the railroads of the country generally, in all efforts to improve and perfect the machinery under our supervision.

We are here for the purpose of carrying out the original object in the organization of our Association, that of receiving and imparting information, and as was said of the habits of many of the ancient Athenians, spend the day in hearing and telling of some new thing. Many of us have attended at almost the entire number of meetings held during the seventeen years' existence of this Association, and

while we may not always have been able to tell of some new thing or to impart valuable information to others engaged in the same calling, I for one, at least, have at every meeting received much information that was valuable to me. If we look back seventeen years and compare the locomotive of that day with the well-proportioned and substantial piece of mechanism of the present, we can but be surprised at the vast improvements that have been made in this comparatively short space of time. Among those who have toiled through weary days and studied far into the nights to perfect the locomotive of that day, this Association was well represented in number. Hundreds have had a share in bringing the locomotive up to its present state of development, and I believe I may safely say that this Association is not the least among the number entitled to that credit. While we may derive satisfaction on reflection of the progress already made, we should not be deluded into the belief that the locomotive is now perfect. As to what improvements are likely to be developed during the next seventeen years, it is idle to speculate, but we may conclude, however, that they will be as marked and important as those made during the past seventeen years; perhaps much more so. It has often been asserted that the railway has built up our country, and the saying is true in part at least, and especially is it so of the West; since the country is, however, now built up, it demands of the railway that it shall do its work for a less sum each year, and in many localities at less than living rates. To meet this demand and still be able to live, the railways must, if possible, still further reduce the cost of transportation. How to do this is a question difficult to solve. We are required, so far as is possible, to reduce the expenses in the department under our supervision, and therefore it is of the utmost importance that we should know what further can be done, if anything, that will result in greater economy. This is a question in which we are all equally interested in having solved. As has been said, the locomotive is yet far from being perfect. As it becomes nearer perfect, it will be more economical; it will do more work in a given time, and a less number be required to do a given amount of work, and a less outlay of capital be required to equip a road with sufficient power. These matters will all work out in

the direction of economy, but in just what particular the locomotive can be improved, and how it can be managed in order to give better results, I will not attempt at present to answer, but will direct your attention to a few subjects only with the view of drawing attention to them and eliciting discussion and criticisms that we may finally obtain additional light.

Fuel being the most expensive of any one item in the running expenses of a road, the boiler may therefore be regarded as the most important part of the locomotive as regards economy. How to generate equal power on a less consumption of fuel is a subject that has claimed much of the attention of a vast number of individuals and of this Association ever since its organization, as the numerous reports of committees and protracted discussions at our meetings will show, but the subject is by no means exhausted. The problem as to the best plan of boiler, proportion of grate to heating surface for a given quantity of steam per minute, for the different kinds and quality of fuel used, has not been satisfactorily solved in any considerable number of cases, if in any. In practice we find a marked diversity in area of grate, where heating surface and quantity of steam required in a given time is practically about the same. For instance, varying from 30 to 60 square feet for anthracite, and from 16 to 32 square feet of grate for bituminous coal, but in consumption of coal to work done we find comparatively little difference between the two extremes. This would indicate that the consumption of fuel on the grate depends to a considerable extent on the volume of air furnished per square foot of grate in a given time; or in other words, on the volume of gases the exhaust is capable of driving out of the stack, and that the ability of the stack to pass through it the requisite volume of gases in a given time, is a matter of as much importance in meeting the requirements in a rapid generation of steam as grate area, especially in the case of high speed passenger engines when working up to full capacity, and it seems to me that the ability of the exhaust and stack to meet the requirements should receive equal consideration with that of grate area and heating surface, in order to produce the best and most satisfactory results.

In the matter of economy in the cost of fuel, it seems to me that

in the case of roads that have large accumulations of slack bituminous coal at the mines convenient of access, which is now regarded as of no value, some further tests should be made in order to determine whether it has any real value as fuel for locomotives or not. The anthracite slack is burned in the Wootten boilers on the Reading Railroad, it is claimed, with very economical results, and it seems to me that with properly proportioned fire-boxes and grates, bituminous slack ought to give equally good results. It would be worth a careful test at any rate at places where there would be little or no cost in handling or in transportation. All plans that give promise of reducing the cost of motive power should be carefully tried.

The compound locomotive of the Dunbar patent, built lately by the Boston & Albany Railroad Co., it seems did not give the good results expected in reducing the cost for fuel, and it has since been changed, as I understand, to one of the ordinary type. Those built by M. Webb, of the London & Northwestern Railway in England, on his plan, are reported as running successfully, but do not show very marked results in economy of fuel over others of the ordinary type on his road, not so much so as was expected, and the prospects of a reduction in the cost of transportation in that direction, at present does not look very encouraging. The impracticability of using a condenser in connection with the compound cylinders in a locomotive will likely prevent this plan of engines, as applied to the locomotive, from giving the economical results shown where condensers are used, as with the marine and stationary engines.

For many years much time, ingenuity and money has been expended with the view of producing a valve motion for the locomotive that would show more economical results in the use of steam than is shown by the use of what is known as the link motion, but the results in practice have in nearly all cases, from one cause or another, proved unsatisfactory, and the link, even with its acknowledged defects, still holds its place. The "Joy" gear, of which greatly increased results in economy was predicted by many of its advocates, as we have used it on locomotives in this country, does not seem to give appreciably better results in practice than is at-

tained from the use of the link, and while it is used to some extent on locomotives in Europe, in England in particular, it is not exclusively used on new locomotives being built, which would indicate that even where longest and most extensively used, it is still a question whether in its practical results in giving motion to the valve, it is an improvement on the link. The question of room for cranks and fire-box has doubtless decided its adoption in many cases, rather than the opinion as to its being a superior motion for the valve.

In the direction of economy, the subject of balanced valves is one of more importance, I think, than we have generally considered it. I believe we have this year a report of a committee on this subject, and I trust that it will be fully considered by the Convention. A good, durable, and inexpensive balanced valve is certainly to be desired, and its adoption would result in economy in reducing wear of valves, seats, and the valve motion generally; increase their durability, and enable the engine to be handled with much greater ease and safety. There are many other minor details of the locomotive that it would be interesting and profitable to consider, which will, I trust, be presented by others during our session.

To maintain the proper degree of interest in our annual meetings as the years pass by, will require systematic labor and efforts on the part of all our members, and the ability to present at each meeting such reports and questions for discussion as will attract attention, and excite a desire for more thorough and exhaustive investigation.

This can not be accomplished by the efforts of a few only, but will require the united efforts of all the members, and others willing and competent to take part. There are, perhaps, but few members who have not the opportunity of investigating for themselves at some time during the year some subject that would be of interest to the members generally, if the results were reported to the convention. As an Association, we have not the means nor facilities for undertaking any expensive tests or experiments in order to settle doubtful or undecided questions, and, if we had the means, it is questionable whether the general results, in proportion to cost, would be satisfactory. The original object of this Association was, that the members might have the benefit of the tests, experiments,

and observation of each other, in whatever form made to the Convention. This is perhaps all that is practicable under existing circumstances. I am confident, however, that if all the members will do what they can in the matters referred to, these annual meetings will never lack in interest, but will increase in importance with each succeeding year.

If we take up any of the various subjects connected with economy in the motive power department, such, for instance, as greater durability of machinery, the best plan of valve motion, best proportion of grate for the kind and quality of fuel used, best type of locomotive for the different kinds of work to be done, and we find there is great diversity of opinion, and I suppose that we would all readily admit that in but very few of these matters have we approached anywhere near the limit of perfection, and that there is still a wide field for investigation and improvement open for the future. Greater economy in the operating expenses of railways than heretofore is a necessity, and the man who depends alone on the investigations made by himself and on his own observations in these matters will most likely be left far behind in the race for substantial and valuable knowledge, and it is only by the united experience and observations of all, and from valuable information gathered from all sources that we may expect to keep up with the demands of the age, and make perceptible progress towards greater perfection.

In the case of a large number of questions that are presented for consideration there is perhaps no other plan so likely to bring out all the facts as a full discussion in open convention. Committees may have carefully considered them and presented their conclusions, yet if afterward discussed by a number of persons, some new light on the subject is generally brought out, and it seems to me, therefore, that at our annual meetings the reading of a report by a committee should always be so timed as to permit of its discussion immediately afterward, while the subject is fresh in the minds of those who hear it read. By postponing discussion, and allowing other matters to intervene, as we frequently have done, the subject, to a great extent, loses its interest in the minds of the members, and is seldom fully revived again.

There is much important work that can be done by this

Association in the future that will result in great benefit both to the members individually, in increasing their theoretic and practical knowledge, and to the advantage of the companies which they represent.

While these annual reunions bring with them much that is pleasing and enjoyable in meeting familiar and well-known faces, and in the renewal of social intercourse with old and valued friends, they also bring a shade of sadness in the reflection that a year seldom or never passes that an announcement is not made that some one or more of our members will be seen no more in these meetings. I regret to have to announce to the Convention, the decease of two of our most esteemed and valued members since our last meeting, in John McFarland, who at the time of his death and for many years previous, was the Superintendent of Machinery of the Chesapeake and Ohio Railroad Co., and Prof. Charles A. Smith, late of the Washington University, St. Louis, Mo., who for several years previous to his death was an associate member of this Association. I trust that this Convention will take suitable action in regard to these deceased members.

THE PRESIDENT—The next business in order is the report of your Secretary. The report of the Secretary was read, and, on motion, accepted.

To the American Railway Master Mechanics' Association:

MR. PRESIDENT AND GENTLEMEN: By virtue of the responsibility you have vested in me as Secretary, I am for the fourteenth time permitted to present to you a detailed statement of the business of my office for the year ending with this our seventeenth annual Convention.

In doing so, permit me to say in the outset that never before in the history of the Association have we met under such favorable circumstances. The growth of the Association in the past year has been remarkable, showing an increase of 34 per cent., and the interest, as manifested in the inquiry for reports and contributions to the printing fund, are greater than any previous year.

Since last report the names of 14 members have been omitted from the rolls for non-payment of dues; one regular and one

associate member have resigned, and, as has been noticed by our President, death has made its annual claim, and John McFarland, Superintendent of Motive Power of the Chesapeake and Ohio Railroad, and Prof. Charles A. Smith, of Washington University, St. Louis, one of our associate members, have been stricken down by his hand. With these changes the Association numbers as follows:

Regular Members	224
Associate "	13
Honorary "	3
Making a total of	240

PRINTING.—Bids were received from four of the most responsible printing houses, and the contract awarded to the Aldine Printing Works, of Cincinnati for the sum of $615.01 for 1200 copies of 288 pages each. Copies of this report have been sent to each member with a modest request for a contribution to our printing fund. In most cases this has been responded to quite generously by the railroads. In some instances a contribution has been made to the printing fund, and then orders given for additional copies, through the purchasing agent, at the regular price. In this manner 900 copies have been distributed to railroads and other corporations, and 300 remain on hand.

The following are the names and amounts of contributions to this fund:

NAME.	AMOUNT.
Concord R. R	$10 00
Baldwin Locomotive Works	20 00
W. W. Evans	17 00
Capiopa	10 00
New York & New England	10 00
New York, Penn. & Ohio	10 00
Brooks Locomotive Works	25 00
Pittsburg Locomotive Works	10 00
Connecticut River	10 00
Boston and Providence	10 00
H. K. Porter & Co	10 00
Cincinnati, Cleveland, Columbus & Indianapolis	10 00
Chicago & Eastern Ill	10 00
Lake Erie & Western	10 00
Chesapeake & Ohio	10 00
Wilmington & Weldon	10 00
Chicago, St. P., Minn. & O	10 00

NAME.	AMOUNT.
Chesapeake & Ohio S. W	10 00
Chicago, Rock Island & Pacific	10 00
N. Y., Susquehanna & W	10 00
Schenectady Locomotive Works	10 00
Lehigh Valley	10 00
Illinois Central	20 00
Portland Locomotive Works	10 00
Taunton Locomotive Works	10 00
Fitchburg R. R	10 00
Lake Shore & Michigan Southern	10 00
Kansas City, Fort Scott & Gulf	10 00
Delaware, Lackawanna & West	10 00
Terre Haute & Indianapolis	10 00
Missouri Pacific	10 00
Louisville & Nashville	10 00
Boston & Albany	10 00
Grand Rapids and Ind	10 00
Norfolk & West	10 00
Des Moines & Ft. Dodge	10 00
J. M. & I. Rwy	10 00
Old Colony	10 00
Mexican Central	10 00
Atchison, Topeka & Santa Fe	10 00
Houston & Texas Central	10 00
Inter-Colonial	30 00
South Eastern	10 00
Rochester & Pittsburg	10 00
F. B. Miles	10 00
Rogers Locomotive Works	50 00
Rhode Island Locomotive Works	10 00
National Tube Works	25 00
Grand Trunk Rwy	20 00
New York, Lake Erie & Western	10 00
Ohio & Mississippi	10 00
	$637 00

The following is a statement of all moneys received and to be accounted for:

Amount by Assessment	$1181 00
" Printing Fund	637 00
" Cash for Reports sold by R. R. Gazette	34 65
" " " " Secretary	52 00
Balance on hand at last report	304 62
Making the total amount to be accounted for	$2209 27

For all of which I hold the Treasurer's receipt.

The following is a statement of the Boston fund at this report:

Principal, as per last report	$4800 00
Interest uninvested, as per last report	208 93
July Int. 1883 on $4800	48 00
Oct. " " " "	48 00
Jan. " 1884 " "	48 00
April " 1884 " "	48 00
Total value of fund at date of this report	$5200 93

This fund, as you will notice, has $400.93 uninvested interest, which, with the principal in government bonds, is subject to the inspection of the members as may be desired.

All of which is respectfully submitted.

J. H. SETCHEL, *Secretary.*

THE PRESIDENT.—The Report of the Treasurer is next in order, and will be read by the Secretary. On motion the report was accepted.

RECEIPTS.

June 21, 1883.	From J. H. Setchel, Sec'y	$1018 00	
June 16, 1884.	" " " "	1191 27	
			$2209 27

EXPENDITURES.

June 21, 1883.	Paid J. H. Setchel for services as Secretary, Voucher No. 1	$600 00	
June 22, "	J. Raymond, Voucher No. 2	65 00	
July 13, "	Richard W. Ryan, Voucher No. 3	65 00	
July 13, "	A. W. Sullivan, Voucher No. 4	4 50	
June 16, 1884.	C. J. Krehbiel	615 01	
	R. R. Gazette	343 17	
	J. H. Setchel, postage	66 60	
	R. R. Gazette	53 93	
	Cincinnati Safe Deposit Co	15 00	
	Wilstach, Baldwin & Co	7 50	
	A. H. Pugh	5 60	
		$1841 31	
	Balance on hand	367 96	
			$2209 27

GEO. RICHARDS, *Treasurer.*

Long Branch, June 16, 1884.

THE PRESIDENT—The Report of the Committee on Boilers and Boiler Construction is in the hands of the Secretary.

MR. H. N. SPRAGUE—Mr. President, I would ask what hour it is that we are to devote to debates on questions submitted by members.

THE PRESIDENT—The hour is from 12 to 1 o'clock, unless there is some other business.

MR. H. N. SPRAGUE—It is now after 12 o'clock, and I should think it would be best to take up the time now for that purpose.

THE PRESIDENT—A motion will be in order, I suppose, to postpone the reading of that report until after the hour for discussion of subjects that may come before the Convention.

MR. H. N. SPRAGUE—I understand that, that hour being specified, it takes precedence without a motion.

THE PRESIDENT—The gentleman is correct, and we will now receive any questions that may be handed up to the Secretary, and proceed to consider them. I believe there are one or two now which have been handed in.

SECRETARY SETCHEL—In reading these questions I would like to remind the members of a rule which has been adopted, providing that any member proposing a question shall open the discussion upon it. The first question I have is: "At what thickness should steel tires be removed to insure safety from accident by breakage," etc. This question was proposed by William Woodcock, of the New Jersey Central Railroad.

MR. WM. WOODCOCK—I was led to propose this question from the fact that on the day I left to come here I was notified that one of our engines had been taken off duty on account of the wheel being broken, and that the supposition was, that it was broken by reason of the tire being too thin, and having been run too long. While I differed in that view, I thought it might be well to ask some of the members what their experience was in that regard, and what they would consider a safe thickness at which to run a steel tire. I have always thought that a steel tire would run to one and one quarter inch thickness. The tire I refer to I do not think had reached that point, but nevertheless it cracked. Now, if we are going to find that by running our tires too thin we shall break our driving wheels, it is time we decide upon some limit at which tires should be taken off. We get better results from steel tires than from iron tires, and as many of the members here have replaced iron tires by putting on steel, I hope they will give us their views. I think in running heavy trains it may be well to consider whether one and a quarter, or one and three-eighths inches is sufficient thickness to insure safety. We don't want to take any chances at the present day.

Mr. H. N. Sprague—I would like to inquire from members who are running locomotives, whether they do not find a marked difference in the safety of running tires on freight and passenger engines—whether there should not be a distinction made between the running of tires on freight and passenger engines.

Mr. A. G. Eastman—It seems to me that that is a question that would be greatly affected by the climate. While I quite agree with Mr. Woodcock that on a light engine you can run a tire down to one and a quarter—as I have done with 30 ton engines—if we are running 40 ton engines on the same wheel, especially in a cold climate, I do not think we should run them so thin as that. I have at the present time several engines running on one and a quarter inch tires, but they are light engines. It is my opinion that we should not run as thin a tire as that under a thirty or forty ton engine. Mr. Woodcock's climate is not so severe as ours, and perhaps he can run them thinner than we. I certainly do not think it is safe to run a one and a quarter inch tire under a forty ton engine.

Mr. J. H. Flynn—I have had some experience in this matter. My experience has been, that a tire thicker than one and a quarter inches has broken, on two occasions, under a thirty-seven ton engine. The original tire was put on and ran for a number of years, and then broke. I examined the tire carefully. There was no flaw in the tire. Its general appearance was all right. I have run tires—as the reverse of that —to one and an eighth, on just as heavy engines, and never had them break. The climate where I live does not affect them much, but these tires broke in the summer. The firm who constructed the engines requested me to give them the thickness of the tires. I did so; one was one inch and one-eighth, and the other only a little over an inch. A person would naturally suppose that the thinner tire broke first, but such was not the case. Now, I can give no reason or cause for this. It could not have been caused by the shrinkage of the tire, else it would have broken before that time. If it had been a very cold day in winter, I might attribute it to the cold weather; but this was not a tire that I considered unsafe to run. In fact, I contemplated turning the tires again when the engine came in. Tires sometimes break from unexpected causes. I have run tires on a light engine down to one and one-eighth inches, and never had any break or get loose.

Mr. J. D. Barnett—I think the point Mr. Woodcock made was that when the tire got thin the wheel broke. I think we have all had experience in running tires thin and breaking the tires. It seems to me, though, that it has been an exceptional experience for a thin tire to

cause the wheel to break. For instance, if I am repairing an engine in the spring months, if I can clear the tire to one and three-eighths, I would turn that engine out for summer work; but I would not dream of doing so in the fall months of the year, and run that engine through a Canadian winter at our temperature of below zero. Undoubtedly the temperature does influence the question. I would put a new set of tires on sooner than risk a thin tire in winter. In Canada we break, I think, a larger percentage of tires than you do here, but I remember no case of a wheel breaking because the tire was too thin. I met with an exceptional experience during the last twelve months of very hard tires requiring to be turned much sooner than tires of medium hardness. Some of you remember the communication that Mr. Dudley, of the Pennsylvania Railroad, made to the directors of that company, in which he came to the conclusion that it would be wiser to specify soft steel for their rails, because he believed that in a very hard rail it was not elastic, did not give, and the point of contact between the wheel and the rail was very small; so that in the very hard steel the rail wore away instead of slightly giving and then recovering itself after the weight was over. It seems to me that the same explanation might cover the very rapid wear of extremely hard tires.

MR. WM. WOODCOCK—Mr. Barnett states the point I wanted to bring up before the Convention—whether by running a tire thin we run the risk of causing the wheel to break. Now, if the wheel is to break because the tire is too thin, of course we don't want to take that chance. The tire that I refer to was not broken; it was the wheel, and the supposition was that the wheel broke because it was not sufficiently supported by the tire. If the tire is not strong enough to support the wheel, why we must run them thicker.

MR. R. C. BLACKALL—There would be quite a difference as to whether the outside of the wheel was cast solid or hollow.

MR. WM. WOODCOCK—The wheel in question was a solid rim, and broke through the spokes. We have a number running with a hollow rim, and we have yet to experience any trouble with them. But this breaking in the spokes, it did not occur to me that the break was caused by reason of the tires being too thin, although that opinion was entertained among some of our men.

MR. R. C. BLACKALL—My experience has been similar to Mr. Woodcock's. We have had several tires break this winter of the thickness of one and three-quarter inches, two inch, and two and a half inch, yet we are running tires at one and a quarter inch. It is our rule if a tire will turn one and a quarter, to turn them, otherwise to throw them away.

We have had no trouble with the breaking of driving wheels with a thin tire.

MR. A. G. EASTMAN—I would like to inquire of the gentleman if he considers a thin tire as safe under a heavy engine as under a light one? It seems to be a matter of the heft of the locomotive. A tire that is heavy enough for a wagon is not heavy enough for a locomotive. In the matter of the tire breaking the wheel, I wish to say, that I think it is generally considered that the shrinkage of the tire keeps the wheel from breaking, but let the tire get loose and the spokes are very liable to part.

MR. CHAS. GRAHAM—Last winter I had two tires, about one and a half inches thick, break on a passenger engine, which I could not account for. I saw no defects in the tire. Now, to off-set that, two years ago I had a freight engine with solid rim the whole width of the tire: the tire seemed tight, and I turned the tires down and they were an inch thick. I ran those tires until they were a three-quarter and a sixteenth and then they did not break. I then had to take the engine for other work, and so could not tell how long the tire might have lasted, but a section of the tire I have preserved and have it now. It was an 80,000 pound engine.

MR. SPRAGUE—I suppose that the present tires of the different makers are more uniform than they have been heretofore. Our judgment of tires that are of the earlier make might not hold good with regard to tires as they are now manufactured. When they first started to make these cheap steel tires, I think there was a lack of uniformity in the tire of different makers. I know there was a very great difference in boiler plate, and I think also in the tires. So the question of a thin tire breaking in one case, and a thick one in another, might be largely due to the quality of the steel.

MR. R. C. BLACKALL—I would like to ask Mr. Graham what brand of steel was on that engine which he spoke of.

MR. CHAS. GRAHAM—They were Krupp tires.

THE PRESIDENT—If there is nothing further, the discussion on this question will be closed.

MR. J. N. LAUDER—Before another question is presented I would like to say a word. It seems to me that our proceedings are out of order, as I can find nothing in our Constitution or By-laws that warrants us in using this hour, without action by this meeting. The business before this Association is the reading of Reports. I think that in order to proceed properly we should vote to have this hour taken up as we are doing, by a vote of this Convention, and I would, therefore, move that one hour of each day be devoted to the discussion of subjects that may be handed

in by members other than committees, and that such hour be from 12 to 1 o'clock.

SECRETARY SETCHEL—For the information of Mr. Lauder I would say, that that very resolution was passed a number of years ago and has been since continued.

MR. J. N. LAUDER—I thought it was only for that one session.

SECRETARY SETCHEL—No, sir; it was to continue, and I was under the impression that it was incorporated in the Constitution, but I see now that it has been inadvertently omitted.

THE PRESIDENT—We have heretofore regarded it as a part of our constitution, and I presumed there would be no objection to continuing it. The Convention can at any time, by resolution, propose to go on with the regular order of business.

MR. J. N. LAUDER—Am I to understand, Mr. President, that my motion is out of order? If it is, I withdraw it and will make another one.

THE PRESIDENT—No, sir. If there is nothing in our By-laws in regard to perpetuating that rule, your motion is in order. Is it seconded?

MR. H. N. SPRAGUE—I second the motion.

Carried.

MR. H. N. SPRAGUE—I now move that the discussion, on the question we have been considering, be now closed.

MR. J. N. LAUDER—I second the motion.

Carried.

SECRETARY SETCHEL—The other question which has been handed to me is as follows: "Why should we not press on our tires cold with a taper fit instead of shrinking them on." This question is proposed by Mr. H. N. Sprague.

MR. H. N. SPRAGUE—I suppose in this matter I have started a hornet's nest—at least I hope I have. I have been putting tires on in that way with our small engines for the last fifteen years, for thirteen years almost exclusively, and I have yet to find any objection to it. I think it is the best way to put on tires, and I question whether these reports of breakages would not have been avoided had the tire been pressed on without the shrinkage of a variation of measurement causing an extreme tension on the steel. Any variation in measurement throws an undue strain on the tire. We all know that a steel tire won't stretch. It will only bear to be drawn tight enough to hold. Aside from the convenience, it looks to me that one advantage is, it avoids heating the tire after it is manufactured and keeps them on a uniform tension. A person can determine how many tons pressure they want to put on a five and a half foot wheel, and then they know they have it a uniform tension in every

case. I have never had a loose tire with five-sixteenths taper in from the face of the tire, cutting the key-way in the rim of the wheel and cutting a little place in the outside of the wheel, a half circle slot in the outside of the tire, then driving in the key and fitting it, and then riveting the end without any nuts or fitting on them inside. I have never had any trouble in doing it that way. The thrust of the flange then is against the taper of the tire. It seems to me there are many advantages in it. I question whether the time is not coming when this plan will be adopted. The Baltimore & Ohio Co. put on tires in that way, but as I suppose they have a representative here, he can speak about that. They did it in that way because they went from the chilled tire to the steel tire. I have never heard anything definite about the result of their operations. I know, with our small engines, I have never had any trouble in doing this, and I am impressed with the idea that it is the best and cheapest way to put on a tire.

MR. J. N. LAUDER—I can see no particular reason why we should go to the trouble and expense of putting tires on locomotive driving wheels, as Mr. Sprague suggests. So far as accuracy of fit is concerned, I presume that every one here has steel gauges to bore tires by and steel gauges to turn and centre them by. I know I have, and they are made with as much accuracy as we would have in the fitting of a driving axle. I never had a broken steel tire, and I have operated roads a good while and have used all kinds of tires, and I believe it is largely due to the care I have taken in having the tire and wheel properly fit each other. A little undue strain will ruin a steel tire and strain it beyond its elastic limit. Winter before last we had records of tires breaking all the way from one and a half to two and a half and three inches thick. The cause, it seemed to me, was that they were strained; that they were under a tension all the time. The tire was too small, and there was too much shrinkage allowed. I believe that to be the true secret of the breakage of a large number of our tires. I don't think it is worth while to go back to the old Baltimore & Ohio idea of putting on chilled tires, fastening them on with bolts and rivets. It is a tedious job, it is an expensive job, and I believe an entirely unnecessary one. Heating a tire with gas just sufficient to expand it a twentieth of an inch in diameter can not possibly injure the structure of the steel or hurt it, and I see no reason why we can not make as complete and desirable a job in that way as in the method indicated by Mr. Sprague.

MR. J. H. FLYNN—I do not agree with Brother Sprague in his views, although he and I do agree on many questions. But the plan suggested by him would, in my opinion, be taking a step backward; it would be

going back to the old way. After the introduction of steel tires many of us perhaps know that the builders put them on as he describes; for instance, the Baldwin Locomotive Works, and in the course of time we experienced trouble by reason of the tires getting loose. They were put on similar to the way in which the Baltimore & Ohio Company puts their cast iron on. That is a practice that has been tried; and I don't think it best to go back to it. I do not think there is the amount of merit in it which Mr. Sprague claims. On a light engine it might do well enough. His class of engines are much lighter than those we generally use on the broad gauge. This system that we have now, if watched, is just as good a system as you can have, but I will admit the fact, as Mr. Lauder says, that you must pay particular attention to the turning of your sizes, centre, and inside size of your tire; men sometimes get neglectful. My habit is to examine and see that the man that works on the driving lathe and bores the tire keeps the sizes accurately. I never heat tire so that even in the night it will show red. Many of us let the steel tire get too warm. That might have some effect. I believe the plan we have at present of putting on steel tires is the best that we can possibly have, and I do not see any necessity of adopting the suggestions of Mr. Sprague.

Mr. H. N. Sprague—I notice, Mr. President, that they are exposing some of the points that I made as against the shrinkage of tires. They think that the tires break because men are careless. The question of not being able to press on a tire as tight as you can shrink it on is certainly not a difficult one.

Mr. J. H. Flynn—I don't take the ground but what you can put it on as tight.

Mr. H. N. Sprague—If we put it on as tightly we avoid any risk of not heating uniformly, and when we have the system perfected I consider it the most economical. When we come to take a tire off we can knock them right off; we don't have to heat the tire to expand them off. It is, therefore, certainly a great deal easier way of taking off tires.

Mr. J. N. Lauder—I would like to ask Mr. Sprague whether, if railroads adopted that system, we would not have to get up a system of tools in order to carry it out. We don't need any system under the present mode of putting on tires. It is simple, plain work. In forcing on tires it seems to me you must have some kind of a machine to force them on with. And so, if we adopt that method we will have to get some special machinery, and then, in my judgment, it will be no better, if as good, as the present. I don't believe that Mr. Sprague's point, which he makes about imperfect workmanship, will hold good. I don't

believe that there are any of us who have not men that we can trust to put on a tire with a gauge as tightly and as close as if forced on.

Mr. H. D. Gordon—It seems to me that it would require just as skilled a mechanic to get that taper right as it would to get the proper shrinkage.

Mr. Jacob Johann—I think Mr. Sprague is a little off on the tire question. The point that I have been looking at for some years was to get along with as little labor as possible. and the less labor I have in attending to my engines the better I like it. Now, to go back to Mr. Sprague's system would be increasing my troubles. It takes a little more mechanical ingenuity to make a taper fit than it does to make a square fit. I have followed this method: I have established uniform sizes of centers, and I use nothing but regular standard sizes, 44, 50 and 56 inches. We have our steel gauges for our centre and tire. I buy my tire bored out. Very frequently I put on a set of tires without the engine losing a trip. I have taken off and put on a set of tires inside o three hours, and I am sure that Mr. Sprague can not do it according to his plan—a tire that would stay until run down to one and a quarter inches—except in very heavy engines, on fast trains and freight trains. The difference between Mr. Sprague and the ordinary Master Mechanic is, that he is a constructor and we are repairers. Of course, in theory these things look very well, but when you come to put them in practice they do not pan out. Once in a while we have a loose tire, it is true, but under the same condition of things he will have two loose tires where we will only have one. I have tried to taper tires myself. When we first began to use steel tires we put them on that way, and I know that I had a great many loose tires, until I bored my tire out and put my centres on straight.

Mr. H. N. Sprague—If the tire is put on just as tight cold as it is hot, I don't see how it is going to get loose any quicker. We worked from chilled tire to steel tire. We could not put on chilled tire very tight. If the steel tire is to be put on just as tight, why won't it stay tight just as long? The keys do not really hold the tires on. They are simply put in as a safeguard and would, in case of a tire getting loose, hold it in place, while a tire shrunk on would give more trouble on the road in case it got loose. But I don't expect to convert this Convention at this time, and I therefore move that the discussion on this question be closed.

Mr. M. N. Forney—Before that is done I would like to call attention to the action of the Car Builders' Association, in regard to the standard difference between the backs of tires. There have been a great many

methods of laying the guard rail on different lines of railroads, an(was thought important that some standard should be adopted for distance between the backs of the flanges of their wheels. I think i also important that there should be a standard of that character app taining to the locomotive department. I would therefore move that standard distance between the backs of tires for tender wheels, locor tive truck wheels, and driving wheels, be four feet five and three-eig inches, which is the standard that the Car Builders' Association h adopted. The standard, as adopted, was four feet five and three-eig inches, but I think it would be desirable if that was changed and proposition was made to alter it in form and say that it shall not be l than five feet four and a half inches. I think it is more important to locomotive department than to the car department, because drivi wheel tires are hand-turned off, so that there is not much difficult working with considerable accuracy in fixing that difference; but w rough cast-iron wheels it is important to have some limit. I think if would simply adopt the standard difference which the Car Builders' sociation have adopted we would be taking a step in advance.

Mr. J. N. Lauder—I would second that motion. I am perfe willing to make the standard the same as the Car Builders' Associat have adopted. My tender wheels are all steel, and I can turn them readily as the drivers, and get them to any exact gauge; but I thi where cast-iron wheels are used for tenders and trucks, that it should put in the form of a limit, and, while I am not going to move an ame ment, I would suggest that that limit be one-eighth of an inch each w

Mr. M. N. Forney—I accept your suggestion.

Mr. J. N. Lauder—That it shall not be less than four feet five an quarter inches, nor more than four feet five and a half inches. Tl gives one quarter of an inch limit.

Mr. M. N. Forney—I accept that.

The President—Mr. Forney accepts Mr. Lauder's amendment, a he can embody that in his motion. I think, Mr. Forney, you bet make your motion in writing, so that our secretary will have it in pro shape. For my own information I would like to ask what gauge of r is contemplated there.

Mr M. N. Forney—Four feet eight and a half inches.

The President—You will remember that a great many roads hav gauge four feet nine inches.

Mr. M. N. Forney—It would not conflict with four feet nine inch because the Pennsylvania limit gauge is now four feet five and a qua inches.

BOSTON AND ALBANY RAILROAD.
52 INCH BOILER,
72 IN. FIREBOX.
1882.

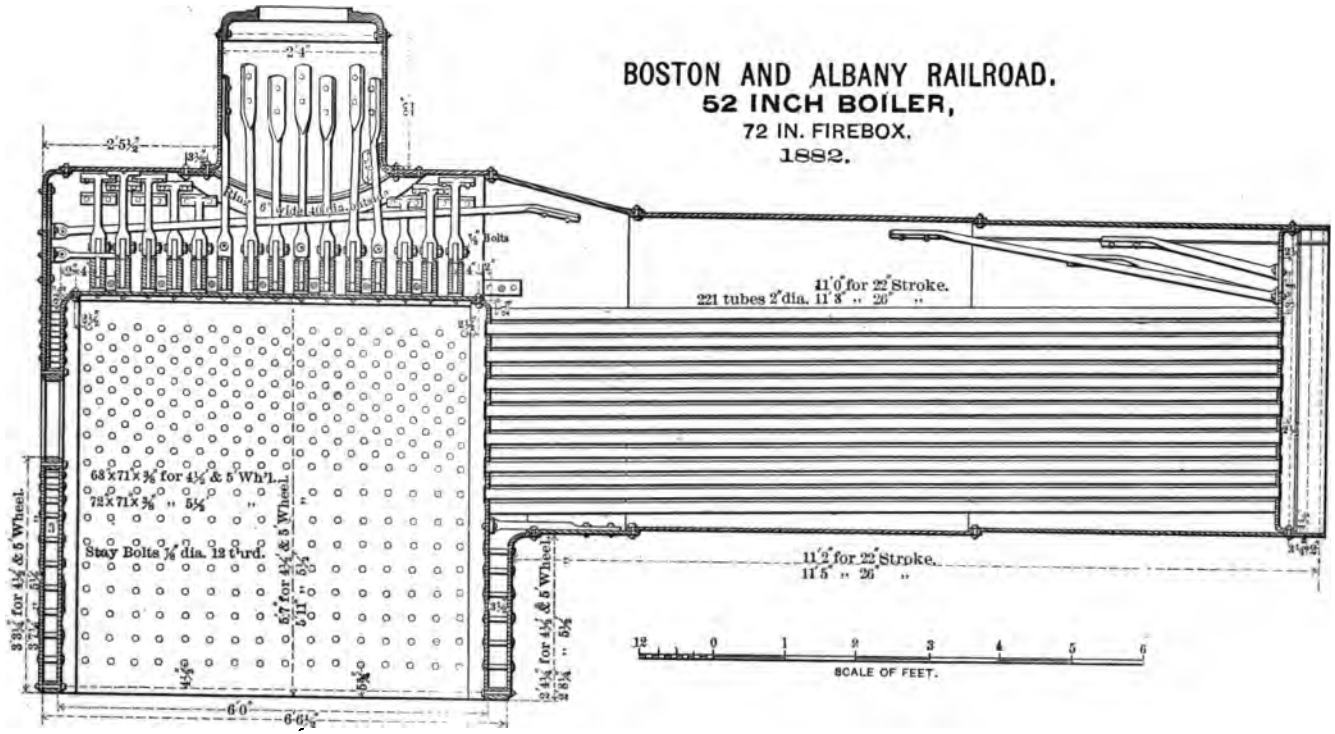


Plate No. 18 A.

which is ¾ inches thick, and also to the smoke arch and barrel of boiler, in which a heavy angle iron plays a prominent part.

PLATE 23—Is an illustration of the Walker smokeless fire box, as applied to a locomotive boiler, and with which a few of the members are familiar. This engine was being tried on one of our prominent roads running into Chicago during our meeting in that city last year. After being tried in the East it made its way out West, and, after having been given extended trials on some of our western roads, it has finally disappeared.

PLATE 24—Is an illustration of the Pusey Boiler used for marine purposes. It shows in detail a novel system of crown staying, the principal point of interest to us. It is cheap in construction, but with 150 pounds pressure, bad water and the severe duty locomotive boilers have to stand, it would require some modifications, the foot of the stays covering too much of the crown sheet surface.

This plan of staying crown sheets is not new, it having been used by our venerable and respected member, Mr. Isaac Dripps, on the Camden & Amboy R. R. as early as 1847 or 1848. The following sketches will also show some more of the modern improvements, as now claimed by several parties as their ideas recently developed, which were also used by Mr. Dripps on the Camden & Amboy Ry. One of these is the sloping diaphragm in smoke box, as follows; another is a water space or wall at front of fire box, same as Mr. Wootten uses in his boiler, but not quite so high as he has it shown at A; also the sloping crown sheet and wide grate, the crown sheet being stayed by braces riveted on, as shown at B, instead of crown bars, being similar to the Pusey boiler.

The committee have now placed before you all the data that they have been able to collect and will now call attention to some of the merits and demerits of the different points that have been brought out. In doing so it is not their intention to criticise each boiler separately, but to simply take up a few of the points in boiler construction and call attention to the various kinds of practice, as illustrated in the drawings presented, with suggestions by the committee as to the probable best and most economical practice.

The first point for consideration that presents itself, is the subject of Fire Door Openings.

Dome Bottom Joint—The mode of strengthening the dome opening, varies considerably, but it is noticeable that more attention is now being paid to this point than it was given a few years ago.

The single flanging of dome plate with a single re-inforcing ring and apparently a single ring of rivets, as shown on Plate 9 Wootten, is the cheapest as regards first cost, but it is doubtful whether the joint can be kept steam tight for any length of time. The arrangement shown on Plates 1 and 2 (New York, West Shore and Buffalo Railway), in which the dome opening in barrel is smaller than the diameter of the dome, and a re-inforcing ring is used also smaller in diameter than the dome, is a much better practice, and although entailing another ring of rivets for the re-inforcing ring, the ring joint need not be steam tight.

The use of a plate ring, as shown on Plate 15 (Great Eastern Railway, England), in which three rings of rivets are used, one inside of dome, one taking dome flange, and the remaining one outside of dome flange, is a very good practice.

The flanging of the barrel up into the dome is also a good practice in the hands of a skillful workman, but great care must be taken not to strain the iron and start a crack, or it will give considerable trouble.

Flanging both the dome and barrel sheets, in conjunction with a ring taking the dome flange ring of rivets with an extra ring of rivets outside, although a little more expensive is undoubtedly the best practice and will give the best results.

Dome Top Joint—The use of cast iron for top ring of dome, still continues to be most generally used. As the metal is very treacherous, an excessive weight of material has to be used, but this weight is in the right location, directly over the drivers.

The objection of taking up steam space can be overcome by making the dome a little higher, and the treacherous nature of the material can be overcome by proportioning the ring section with a large margin for safety. The objection to a square plate ring or to a specially rolled plate ring, is that the dome cover joint is large in circumference, requiring too many studs to keep it tight. With a cast iron ring the opening can be made smaller and fewer studs used. To avoid the use of studs, a majority of which are broken every time a dome cover is removed, the Pennsylvania, West Shore

from back head sheet to front tube sheet direct instead of from back head to front ring of barrel, and from front flue sheet to second ring of barrel.

These long fore and aft stays between back head and front flue sheet, as probably many of you have experienced, have proven to be a source of considerable annoyance, and cannot be regarded as being reliable. As a substitute for this manner of staying back head and front flue sheet, we would suggest angle gusset stays, either forged solid or built up of plate and angle iron, as shown in Plates 1 and 2 (New York, West Shore and Buffalo Railway) and Plate 13 (Caledonian Railway). They are light in weight yet strong, and can be arranged to give all the elasticity required. For example see Plates 19 and 20 (Canadian Pacific Railway) and Plates 21 and 22 (Grand Trunk Railway). This style of gusset staying has been in use for some considerable time, and we have never yet heard of their proving unequal to the duties they are required to perform. A tendency to make the front flue sheet more elastic is to be noted in the drawings of the English boilers; Plate 12 (London and Northwestern Railway), Plate 14 (Caledonian Railway), and Plate 15 (Great Eastern Railway). The Pennsylvania Railway (Plate 4) is also moving in the same direction, as are also the Canadian Pacific (Plates 19 and 20) and the Grand Trunk (Plates 21 and 22). As a means of avoiding cracks in flange of flue sheet, and in the metal bridges between the flues close to the barrel, the practice is certainly in the right direction and will more probably secure its designed end than by re-inforcing with angle iron on the rear side of front tube sheet, as shown on Plate 5 (Lake Shore and Michigan Southern).

CROWN SHEETS—Among the drawings presented, one of the most noticeable points concerning crown sheets is the simple expedient shown on Plates 5 and 6 (Lake Shore and Michigan Southern Railway) of putting an ⅛ inch plate under the double plate or open crown bar, so as to catch and hold the scale that would otherwise fall on the crown sheet. It is questionable, however, whether the use of this plate, by restricting the escape of the steam, would not interrupt the circulation or free supply of water to this point, where the evaporation is so rapid.

An inspection of the drawings presented will show that the use ; the long direct stays between fire box and boiler crowns, is comg into frequent use, and justly so. For a near approximation to ι unobstructed crown sheet, this method of staying cannot be celled. It combines all the elements of safety, cheapness and liability, and is certainly deserving consideration by those who ve not yet tried them.

In May of this year, an engine on the Wabash, St. Louis and cific Railway, which was built in April, 1879, and has been in ssenger service ever since, was opened out for inspection. The sult of the inspection was that the crown sheet was in good conion, every one of the long stays perfectly sound and that the own sheet needed no cleaning. The only sediment was a light m over the sheet with less than a ¼ fillet of sediment around the se of the crown stays, on some of which the thread could still : distinguished.

For over five years this engine has been running without having e crown sheet cleaned or touched, and that on a district where e water is so bad that on crown bar boilers a run of from nine to relve months is more than sufficient to fill the crown sheet with ud and scale to the very top of bars. During this time the enine made a mileage of 209,315 miles.

This system of staying renders the arching and sloping of crown heet more permissable than when crown bars are used, which in self serves as an active factor in keeping the crown sheet free from ediments.

Among the drawings presented we find that in America the folowing roads are using this system of staying, varying in a few nimportant particulars, principally in regard to the manner of ecuring them to the sheets: New York, West Shore & Buffalo, ennsylvania, Chicago, Rock Island & Pacific, Reading, Louisille & Nashville, Canadian Pacific and Grand Trunk Railways.

Plates 1 and 2 (New York, West Shore & Buffalo) show this stem applied in an excellent manner—the crown sheet extending wn considerably below the centre line of boiler to meet the side eet, thus greatly facilitating the renewal of half side sheets. The ennsylvania and Louisville & Nashville systems are modifications

FLUES.—It is very evident that much variation exists as to diameter of flues used, and we fail to trace any approach to uniformity or systematic rule in this matter.

The Pennsylvania Co. (plate 4) use 2¼-inch flues for soft coal and 2½ for hard coal. The New York, West Shore and Buffalo (plates 1 and 2) use 2-inch flues for switching and 2¼-inch flues for road engines, apparently both burning soft coal. Wootten (plate 9) is content with 2 inch flues for hard coal. Have flues of less diameter than 2 inches been used with success for anthracite fuel? There should not be much difficulty in keeping inside tube surface clean. Dirt or soot gathering is the reason sometimes given for not using flues of small diameter for soft coal.

The Great Eastern Railway (plate 15) get 201 1¾-inch flues, with an internal shell diameter of 49 inches, and the Caledonian Railway (plate 13) 209, inside of a 50-inch shell, which, with the tie bolts through from flue sheet to flue sheet, must be considered very close packing.

The following list gives data from which the average European practice can be seen, and it should be borne in mind that there is as much difference in area (outside measurement) between our maximum of 2½ inches in diameter and our minimum, 2 inches, as the total area of a 1½-inch flue, the smallest used in Europe. In other words, the areas of a 2-inch and a 1½-inch flue together, just equal the area of a 2½-inch flue. The absence of uniformity as to the vertical or diagonal arrangement of the flues is also to be noted. The Caledonian Railway (plates 13 and 14) use both, apparently being guided by the geometrical arrangement that will enable them to insert the greatest number of flues in a given space. Have any of the members tried both, and, as a result of the experiment, not of theory, arrived at a settled practice? The flanging out to extra width of the back flue sheet at centre line of boiler, and setting back the side sheet of inside fire box just at that point only, to meet this flanging, and thus securing wider bridges for a given number of flues, or a greater number of flues for a given bridge, as shown on plate 14 (Caledonian Railway), and plate 16 (London, Brighton & South Coast Railway), permitting the side water spaces, except at one narrow point, to be wide and free, is good practice, and is

being adopted by some of the builders on this continent, Chicago & Grand Trunk for instance.

FLUE LIST.

ROAD.	Size of Cylinders.	Size of Drivers.	Diameter of Boiler inside Smallest Ring.	Diameter of Flues.	Number.	Length of Flues.	Size of Bridge Between Flues.
N. E. Ry., Fletcher. . . .	17 x24	7′	50 ″	$1\frac{9}{16}$″	254	10′ $8\frac{1}{4}$″	[illegible]
H. Ry., Jones	18 x24	6′ 3 ″	$47\frac{1}{4}$″	$1\frac{3}{4}$″	223	11′ $2\frac{1}{4}$″	.
G. & S. W. Ry., Hirling .	18 x26	7′ 1 ″	49 ″	$1\frac{1}{2}$″	252	10′ $4\frac{1}{2}$″	[illegible]
N. B. Ry., Drummond . .	17 x24	7′	$50\frac{7}{8}$″	$1\frac{3}{4}$″	216	10′ $5\frac{5}{16}$″	[illegible]
N. B. Ry., Drummond	18 x26	6′ 6 ″	52 ″	$1\frac{3}{4}$″	222	10′ $7\frac{15}{16}$″	[illegible]
L. C. & D. Ry., Kirtley . .	$17\frac{1}{2}$x26	6′ 6 ″	50 ″	$1\frac{3}{4}$″	200	10′ 6 ″	[illegible]
N. Ry of France, Delberque.	$16\frac{1}{2}$x24	6′ $10\frac{1}{2}$″	. .	$1\frac{3}{4}$″	201	11′ $5\frac{3}{4}$″	.
L. & N. W., Well	18 x24	5′ $1\frac{1}{2}$″	48 ″	$1\frac{7}{8}$″	199	10′ 1 ″	.
L., T. & S. E. Ry	17 x26	9′ 1 ″	49 ″	$1\frac{5}{8}$″	200	10′ 10″	.
G. & S. W. Ry., Smellie .	18 x26	6′ $9\frac{1}{2}$″	49 ″	$1\frac{5}{8}$″	240	10′ 9 ″	.
L. & B. Ry., Stondley . . .	18 x26	6′ 6 ″	51 ″	$1\frac{1}{2}$″	331	10′ $8\frac{1}{4}$″	.
G. E. Ry., Worsdell . . .	18 x24	7′	49 ″	$1\frac{3}{4}$″	201	11′ $9\frac{1}{4}$″	.
G. W. Ry., Dean	. . .		$51\frac{1}{4}$″	$1\frac{1}{2}$″	268	11′ $6\frac{1}{4}$″	.

The Committee, after closing their report, received additional information from various places and among them a letter and tracings from Mr. William Thow, M. E. Locomotive Engineer of the South Australian Railway. This additional matter was exhibited at the annual convention held at Long Branch, and considered of sufficient importance to be published with the body of the report.

J. H. Setchel, Esq., Secretary Railway Master Mechanics' Association:

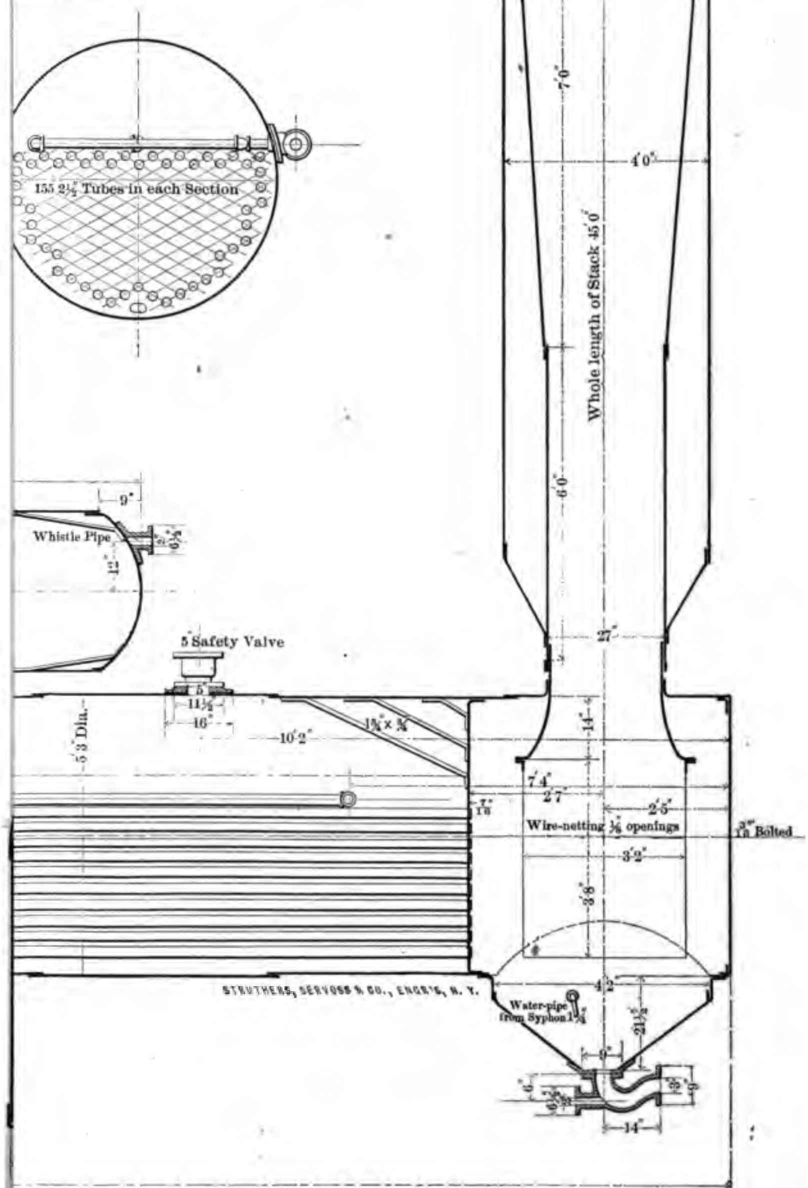
Dear Sir—I duly received a copy of the Sixteenth Annual Convention Report and was much interested. Noticing that the investigations of the Boiler Committee is still unfinished, I take the liberty to enclose a tracing, No. 1718, showing one of our most recent designs of boilers, which I am applying exclusively both to new and old engines belonging to these Railways. The arrangement and the materials employed do not differ in any marked manner from ordinary English practice, except that the method of staying the back of the fire-box shell to a cross plate riveted to the barrel of the boiler above the tubes in front of the fire-box is unusual, and

JONES COMPANY,

, DELAWARE.

METER, 72" STROKE, STERN WHEEL STEAMER.

UBES EXTRA.



I shall be pleased at any time, so far as I can, to comply with any invitations to furnish our experience which your Committees of Enquiry may desire.

I am, dear sir, yours faithfully,

WILLIAM THOW, M. I. M. E.,

Locomotive Engineer, South Australia.

PLATE 26—*a* and *b* are illustrations of a South Australian Railway boiler.

This boiler is of the straight top type, 48 inches inside diameter at smallest ring, and has 201 brass tubes 1⅞ inches outside diameter, 10 feet 7¼ inches long; fire box is 4 feet 5 inches long and 3 feet 7⅝ inches wide, designed for slab frame.

Fire box is of copper, with flat crown sheet stayed by longitudinal crown bars. The crown bars are supported by sling stays suspended from heavy angle irons which are riveted to outside shell of boiler. The crown sheet has a water leg.

The back head of boiler is braced by a cross-plate riveted to barrel of boiler, above tubes, in front of fire box. This plate is strengthened with angle irons, through which long rods are run and bolted to back head.

The front flue sheet is stayed by a cross-plate riveted to barrel of boiler and connected to front flue sheet by two angle irons. Circumferential seams, lapped and single riveted; longitudinal seams, butt double riveted, with inside and outside welts.

PLATE 27 –*a* and *b* are illustrations of a Coventry boiler, presented by Brooks Locomotive Works, Dunkirk, N. Y. This boiler is of straight top type, 60 inches inside diameter at smallest ring, with 152 2-inch flues, 11 feet 5⅛ inches long, and 43 three-inch return flues 11 feet 5⅛ inches long.

Fire box is 5 feet 10 inches long and 2 feet 10 inches wide. It has a flat crown sheet, stayed by stay bolts 8¾ inches long, running through smoke box sheet and riveted on each end. This boiler has two smoke boxes, one in front and the other over fire box. The stack is placed back of dome.

The Brooks Locomotive Works are building one of these engines for experimental purposes and we will probably have a report by the next annual convention.

PLATE 28—*a*, *b*, *c*, *d*, *e*, *f* and *g* are boilers and appliances used on the Camden & Amboy Railway as early as 1833 and designed by Mr. Isaac Dripps. Many of the so-called modern improvements can be traced back to these boilers. As a matter of history it would be well to preserve these plans.

A review and comparison of our reports for the last few years shows us that there are some points in boiler construction, upon which we have arrived at a general uniformity of opinion, and which may be enumerated as follows:

1st. The keeping of all longitudinal riveted joints above the water line.

2d. The use of butt or welt longitudinal joints, instead of single or double lap joints. This practice chiefly doing away with furrowing at seams.

3d. Use of mild steel for all parts of shell and inside fire box.

4th. Wide water spaces surrounding fire grate. Never less than 3 inches and 4 inches preferred, if possible, the width increasing upward rather than narrowing, thus securing better circulation, and freely getting rid of the steam as fast as it is formed.

5th. Clearance space between flues not less than ¾ of an inch.

6th. Disuse of inside ferrules to secure flues in tube sheet, a practice still common in other countries.

7th. Exclusive use of lap welded iron or steel flues, instead of composition ones.

8th. Disuse of solid fire door ring around fire door opening.

9th. As few holes as possible through shell for connections, cocks, valves, etc., and as many as necessary for washing out purposes.

10th. Dome opening to be reinforced by strengthening plate or double flanging.

11th. Rocking grates for bituminous coal.

12th. Leaving boiler free from movement on engine frame, and the abandonment of back boiler head braces even with slotted holes, to allow for expansion.

13th. Original or construction test by hydraulic pressure through injector, and therefore with warm water, but all subsequent tests by inspection with hand and eye, both internally and externally.

14th. Not attempting to get rid of mud by providing with mud pockets or drums, but by blowing boiler off under full head of steam.

15th. There is also to be noticed an increased initial pressure of from twenty to thirty pounds per square inch, and we see no reason why this practice should not become still more general, and the pressure steadily grow higher. Our steam is used so rapidly after formation, and is therefore, so wet that there is little cause for fear of trouble resulting from the higher temperature of the steam interfering with the smoothness of the working faces of valve and cylinder. This temperature is not increased one-tenth in raising steam from 140 to 200 lbs. pressure, and if the full economical value of compounding locomotive cylinders is to be obtained, the pressure must be increased above 150 or 160 lbs., which is the maximum of to-day.

Having called your attention to some of the points in boiler construction, upon which we are almost unanimous in opinion, we will proceed to call your attention to some other points upon which we are not so unanimous, there still being a great diversity and wide range of opinion.

Many of these are points that we can settle, and the sooner they are settled the more at ease we will feel in the consciousness of performing our duties in the most economical manner. In enumerating these points it is desirable that the members present make special note of them for the purpose of discussion at this or succeeding meetings, as it is only by doing so, that any definite conclusions can be arrived at.

1st. The proper diameter of flue for a given class of coal.

2d. The proper clearance or space between flues and their geometrical arrangement.

3d. The fire grate area and proper amount and division of air openings for rapid and thorough combustion of different qualities of coal.

Mr. Wells, on page 17 of the Fifteenth Report, says, that area of live grate should be as small as possible. Mr. Wilder says, grate 120 inches long is economical for soft coal. Who can reconcile the difference of opinion?

COVENTRY BOILER.

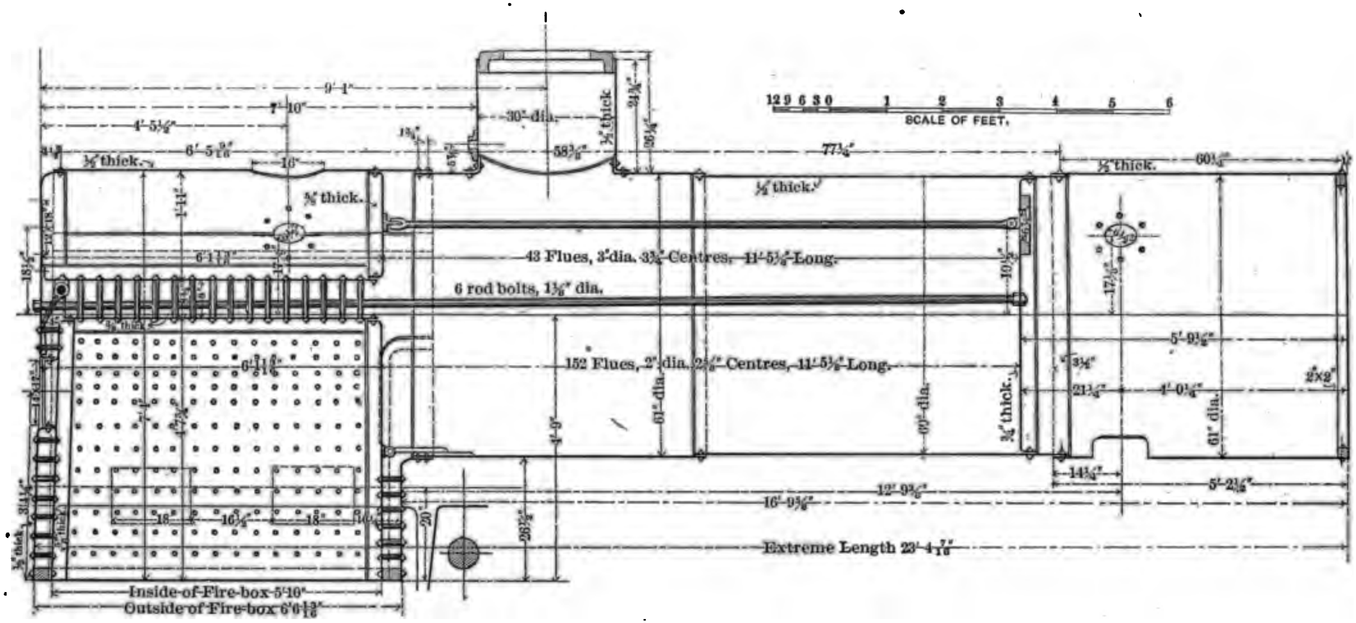


Plate No. 27 A.

COVENTRY BOILER.

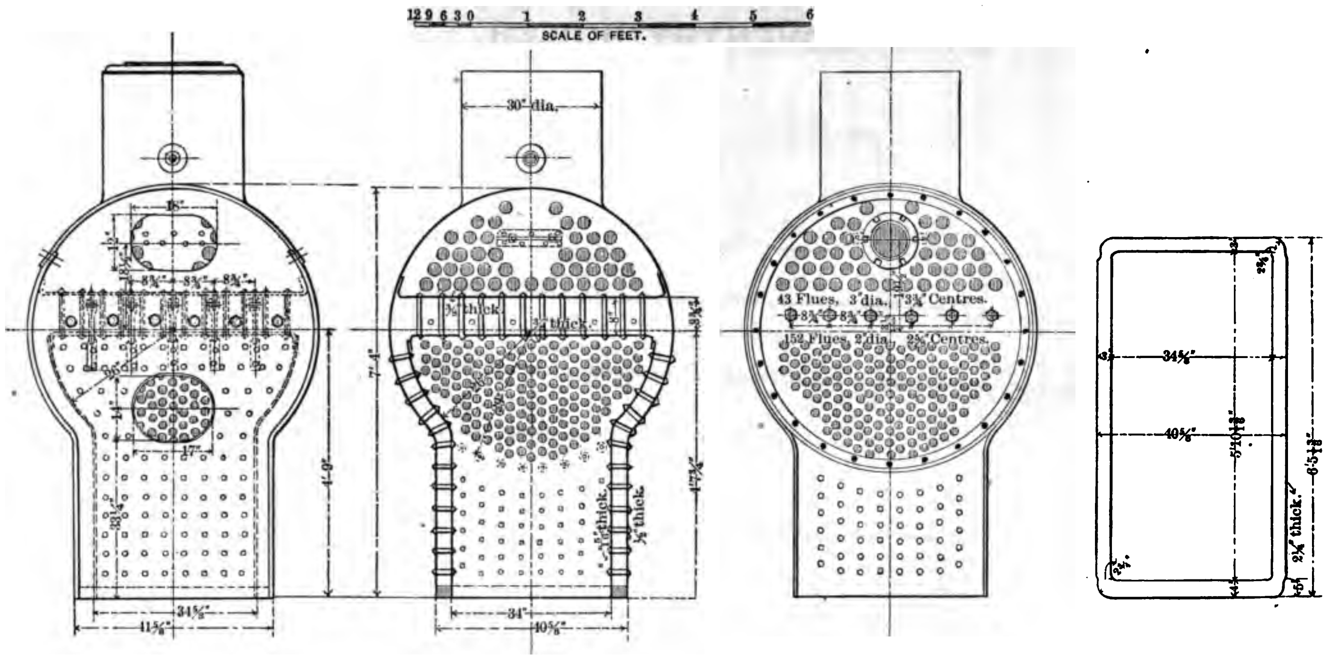


Plate No. 27 B.

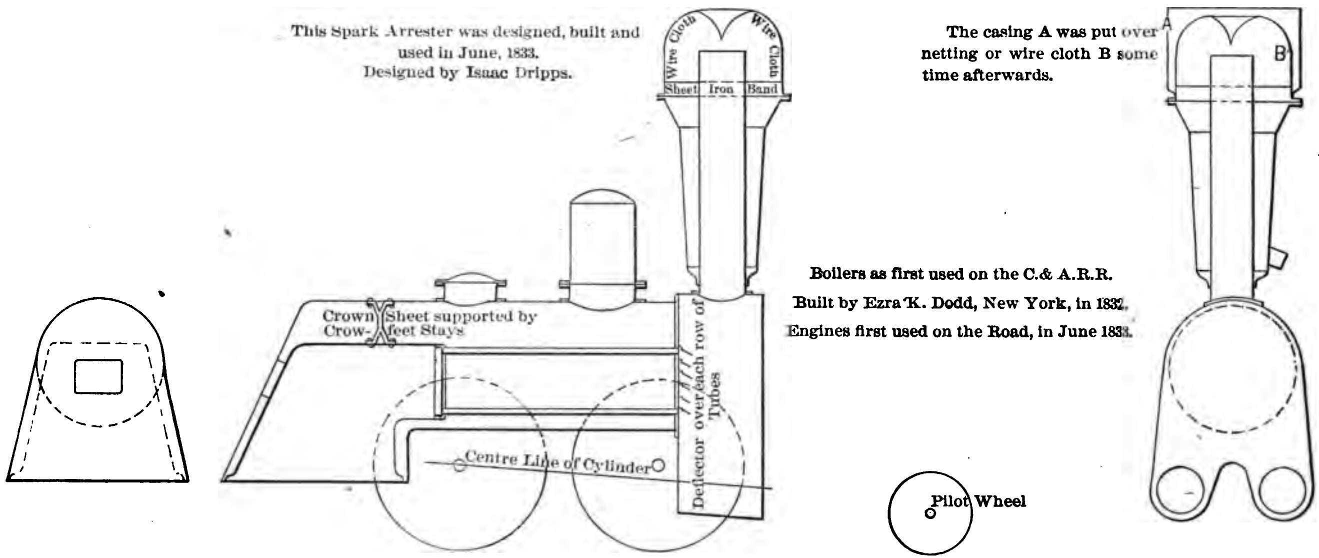

This Spark Arrester was designed, built and used in June, 1833.
Designed by Isaac Dripps.
Wire Cloth
Wire Cloth
Sheet Iron Band
Crown Sheet supported by Crow-feet Stays
Deflector over each row of Tubes
Centre Line of Cylinder
The casing A was put over netting or wire cloth B some time afterwards.
A
B
Boilers as first used on the C.& A.R.R.
Built by Ezra K. Dodd, New York, in 1832.
Engines first used on the Road, in June 1833.
Pilot Wheel

Plate No. 28 A.

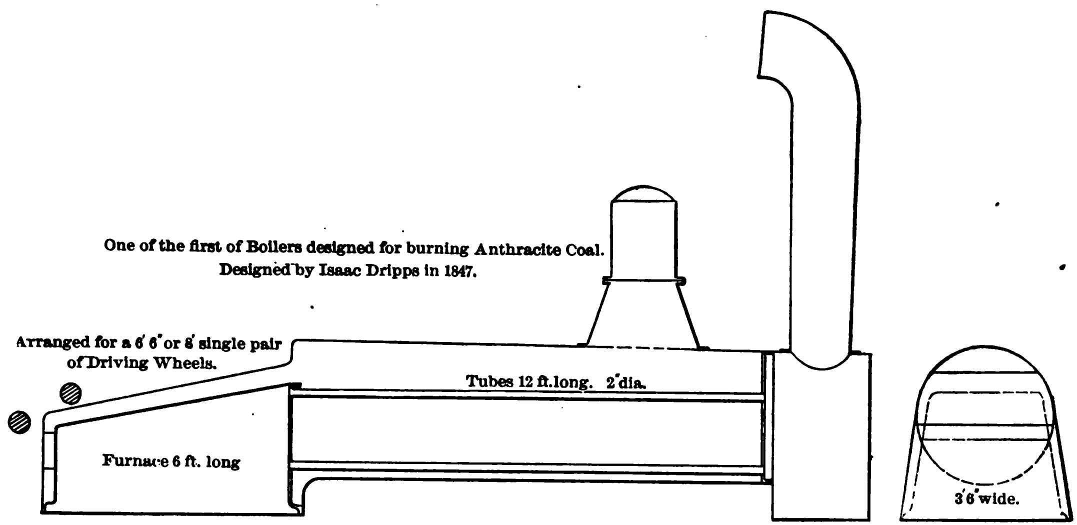

One of the first of Boilers designed for burning Anthracite Coal.
Designed by Isaac Dripps in 1847.
Arranged for a 6' 6" or 8' single pair
of Driving Wheels.
Tubes 12 ft. long. 2" dia.
Furnace 6 ft. long
3' 6" wide.

Plate No. 28 B.

pounds hauled per lb. of coal or in other words the greater the effect obtained from a given amount of coal.

SHEET 2—Gives the results of the pyrometer experiments, readings having been taken during one trip each of each of the passenger trains on the district, both with and without the consumer in use.

The general average temperature of the gases with the smoke consumer in use was 825 degrees, and with the consumer not in use 882 degrees. That is the temperature of the gases escaping from the flues was 57 degrees or 6½ per cent. higher, with the consumer not in use than with it in use.

This result may be accounted for in two ways. The first, and as I believe, the correct way of accounting for it, is by supposing that the admission of air and steam over the fire has the same tendency to lower the temperature of the gases escaping through the flues; that the opening of the fire door does while in the act of shoveling coal, though to a lesser and more continuous extent.

Another way is to account for it by supposing that the use of the consumer has a tendency to lessen the effect of the exhaust, thereby diminishing the velocity of the gases through the flues and allowing a longer time for the heat to become absorbed.

PLATE 29—Is a graphical representation drawn to scale of the figures shown on Sheet 2. Each of the first four temperature lines represents the average observations of two trips. The full lines being for East bound and the dotted lines for West bound trips.

The fifth and sixth lines are the averages of the third and fourth, and the first and second lines.

This sheet will enable you to see at a glance the variations of the several average temperatures, these variations being considerably greater with the device in use than without it.

The lowest average temperature between any two stations with the consumer in use being 663 degrees and the highest 935 degrees, being a variation of 272 degrees. Without the consumer the lowest average temperature between any two stations was 787 degrees, and the highest 943 degrees, being a variation of 156 degrees.

The East and West bound temperature lines approximate very

closely to the profile of the road between Springfield and Tilton, after making an allowance in two or three places, for points where engineers make the practice of "catching time" by running faster.

SHEET 3—Is taken from the "United States Signal Service Weather Report" for the Springfield, Ill., district, and will show approximately the weather conditions under which the experiments were conducted.

For the benefit of those who are not familiar with this device I submit plate No. 30, which explains in detail the application of the Hutchinson device.

The steam and air as shown is admitted through three openings in the front and three in the back of the fire-box, each steam jet opening having a diameter of 7-64ths of an inch.

The jets at the back of fire-box are placed a little higher than those in front, to counteract the tendency of the front jets to throw the flame and cinders out of the fire door while shoveling in coal.

There is also another jet of steam directed up the stack, that is constantly open while on the road, to insure a draft through the flues while the engine is standing still at stations.

As a result of these experiments I am led to conclude that in so far as economy in the consumption of fuel is concerned, there is no appreciable gain in the use of this device. Careful firing being a necessity for obtaining economical results, whether with or without the consumer, and I have no doubt but that a careful engineer and fireman can show nearly, if not quite, as good results without as with the device in operation.

As far as the consumption of the smoke and finer cinders is concerned, there can be no doubt but that it is accomplished to a certain extent, but it requires judicious firing; for with an indifferent fireman as much smoke is created as without the device, and if at any time, through carelessness, the fire-bed was allowed to raise above the jet openings, the effect of the device became nullified.

With our light trains the smoke can be consumed to a great extent, but with our heavy trains, when the engine is working hard, the smoke rolls out in spite of the most careful manipulation.

As more steam is required to be made with the device in operation, to supply the wastage through the six openings in the

fire-box and the one in the smoke arch, it is my opinion that the fuel that would be saved by the more perfect combustion is used in making this extra amount of steam.

The use of this device has an attendant annoyance that is very disagreeable, and that is the continued roaring noise which is so loud that it can be distinguished in the first coach, and which is decidedly unpleasant for the engineer and fireman.

As many of you are aware, the use of the steam jet to prevent the creation of smoke is by no means of recent date. In D. K. Clark's book, "The Locomotive Engine," published in 1860, I find the same principles set forth as are embodied in the "Hutchinson Device," and I present herewith illustrations of two such devices as published in this book.

Plate 31 shows one of the first applications of the steam jet to promote combustion, and which was used as early as 1838.

Plate 32 shows D. K. Clark's device for using steam inducted air-currents and was used on locomotives in England as early as 1858—the steam and air, however, being admitted at the sides, instead of the front and back of the fire-box. He also used the steam jet in the smoke arch, which he called blow pipe.

In this country many of you have probably tried one or more modifications of Clark's method, and as an illustration of one of these applications, I present Plate 33.

In conclusion I would say that the name "smoke consumer" appears to me to be a misnomer, although I have made use of it in this paper.

JACOB JOHANN.

MR. JACOB JOHANN—I desire to say to the members that since arriving here I have received some further matter pertaining to the report, which is of general interest, and in connection therewith is a drawing from a gentlemen in Australia, and I have received from the Brooks' Locomotive Works a novel boiler drawing, which I, as one of the Committee, would recommend be embodied in this report. I would suggest that the Committee on Boilers, in conjunction with the Supervisory Committee, be empowered to embody these in the report, and with that I move the report be received.

MR. J. N. LAUDER—I second the motion.

SECRETARY SETCHEL—You mean, Mr. Johann, that it is to be left to

the Advisory Committee to say how much of it shall be embodied in the report.

MR. JACOB JOHANN—Yes, sir.

(The question was then put upon Mr. Johann's motion, and the same was declared carried.)

THE PRESIDENT—The subject is now open for discussion and we will be glad to hear from any members upon it.

MR. H. N. SPRAGUE—I move that we now adjourn until to-morrow morning at 9 o'clock, and that the discussion of this report go over until that time.

MR. J. N. LAUDER—I second the motion.

Carried.

The Convention thereupon adjourned until Wednesday morning, June 18th, at 9 A. M.

SECOND DAY'S PROCEEDINGS.

The Convention was called to order by President Wells at 9:30 A. M.

MR. J. N. LAUDER—Before discussion is commenced on the report of the Boiler Committee, I would like to make a motion that the various necessary committees be appointed. I would therefore move that the following committees be appointed at this time: Auditing Committee; Committee on Assessment; Committee on Resolutions; Committee on Place of Meeting; Committee on Nomination of Officers; and Obituary Committees.

MR. H. N. SPRAGUE—I second the motion.

Carried.

THE PRESIDENT—I will announce the members appointed on these committees before we close our session this afternoon. The discussion of the Boiler Committee's report is now in order.

SECRETARY SETCHEL—I notice that we have among us this morning one of the oldest Master Mechanics in America, and I would like to have him invited forward and presented to the Association. I refer to Mr. Isaac Dripps.

MR. M. N. FORNEY—I move that Mr. Dripps be invited to take a seat at the right of the President.

MR. J. N. LAUDER—I second the motion.

Carried.

(Mr. Dripps was then escorted to a seat at the right hand of the President and presented to the Association by the President.)

WABASH, ST. LOUIS & PACIFIC R'Y. MACHINERY DEP'T

Pyrometer Tests with Hutchinson's Smoke Consumer on Passenger Engine 565, during May and June, 1883.

SMOKE CONSUMER IN USE.

STATION.	EAST BOUND.			WEST BOUND.			General Average East & West Bound.
	No. of Readings.	Total Deg. of Heat in Smoke Arch.	Average.	No. of Readings.	Total Deg. of Heat in Smoke Arch	Average.	
Springfield	20	14435°	722°	13	11365°	874°	782°
Riverton	24	18745	798	9	7405	823	792
Dawson	20	15015	751	9	7375	819	772
Buffalo	16	10600	663	10	7415	742	693
Lanesville	34	23965	705	12	9960	830	737
Illiopolis	22	16580	754	12	10650	888	800
Niantic	25	19896	796	9	8365	929	831
Harristown	31	24035	795	17	15660	921	827
Decatur	23	19435	845	12	10730	894	862
Sangamon	17	14740	867	10	8690	869	868
Oakley	22	18560	844	12	10370	864	851
Cerro Gordo	21	17390	828	13	12060	930	866
Milmine	20	16245	812	13	12155	935	861
Bement	27	23595	881	17	14880	875	874
Ivesdale	25	21025	841	15	13115	874	853
Sadorus	18	15755	875	18	15985	888	882
Tolono	27	22780	844	16	14010	875	855
Philo	16	12970	811	11	10215	929	854
Sidney	26	21740	836	9	7900	878	847
Homer	27	21305	790	12	9970	830	800
Fairmount	28	21530	762	7	6250	880	794
Catlin	8	5925	740	7	6395	913	821
Tilton							
	497	396266°	797°	263	230900°	878°	825°

SMOKE CONSUMER NOT IN USE.

STATION.	EAST BOUND.			WEST BOUND.			General Average East & West Bound.
	No. of Readings.	Total Deg. of Heat in Smoke Arch.	Average.	No. of Readings.	Total Deg. of Heat in Smoke Arch.	Average.	
Springfield	21	19590	933	19	17550	924	928
Riverton	22	18240	829	20	18050	903	864
Dawson	17	13710	807	16	14305	894	849
Buffalo	16	13220	826	15	13245	883	854
Lanesville	20	16210	811	20	17855	893	852
Illiopolis	17	13380	787	22	19570	890	845
Niantic	25	21925	877	16	13250	828	882
Harristown	31	27705	894	38	33865	891	891
Decatur	18	16970	943	23	20665	898	918
Sangamon	14	13010	929	18	15185	844	881
Oakley	17	15130	890	25	21415	857	870
Cerro Gordo	16	14560	910	25	22320	893	899
Milmine	13	11540	888	13	11500	886	881
Bement	26	23505	904	28	25350	905	905
Ivesdale	29	26110	900	25	22510	900	900
Sadorus	27	24780	918	20	17460	873	899
Tolono	26	23210	893	24	21070	878	886
Philo	21	17565	836	23	20850	907	873
Sidney	33	28370	860	23	20620	879	873
Homer	30	26960	899	24	20610	859	881
Fairmount	31	26980	870	25	21610	864	868
Catlin	2	10780	898	15	13750	917	909
Tilton							
	482	423650°	875°	477	422605°	886°	882°

Sheet No. 2.

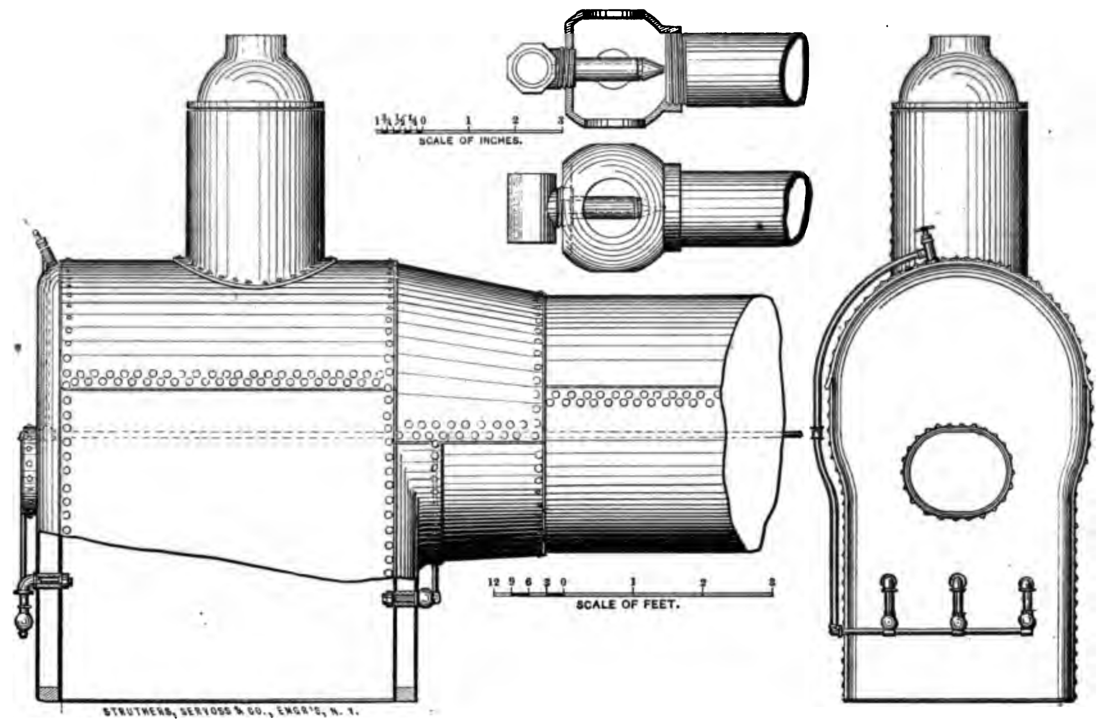


Plate No. 30.

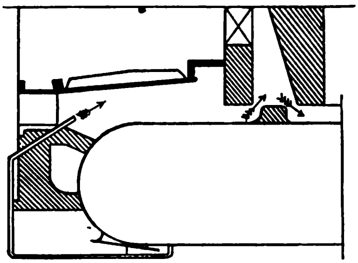


Plate No. 31.

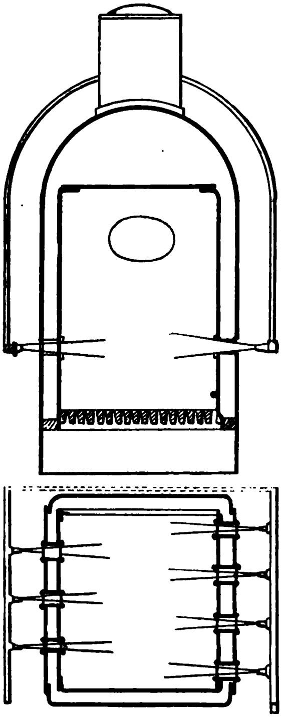


Plate 32—1.

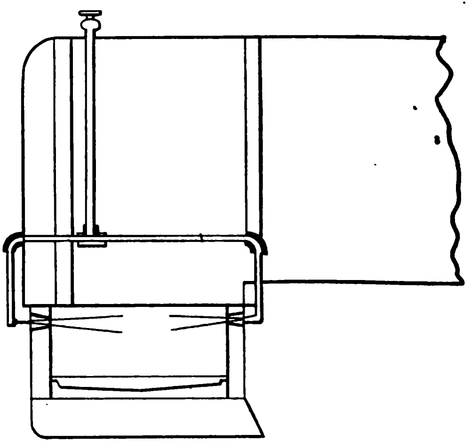


Plate No. 32—2.

Fig. 1

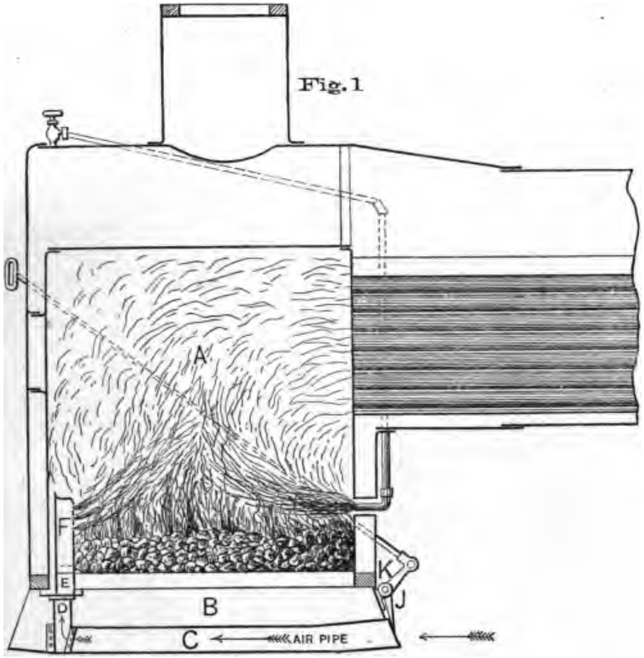


Fig. 2

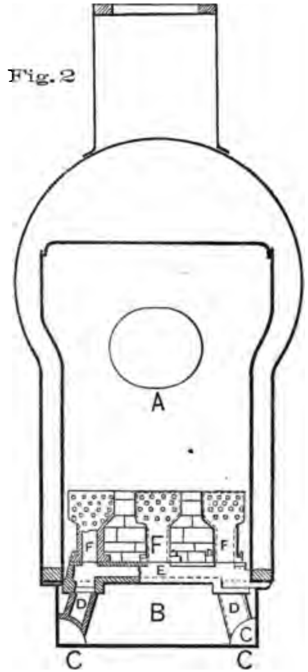


Fig. 3

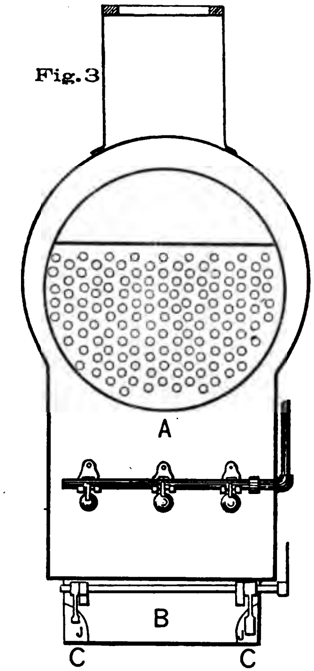
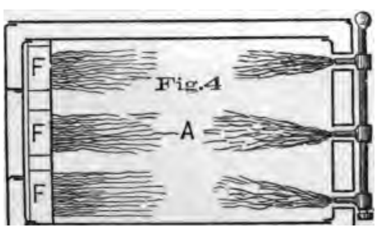


Fig. 4



C. J. Hagstreem's

SMOKE BURNER.

PATENTED NOVEMBER 21, 1876.

Plate No. 33.

not troubled with cracked fire-boxes. We used copper a long time, but they would wear two or three years and then we had to take them out. Finally we came back to steel. Before we used copper we had used steel, and had a good deal of trouble with the cracking of fire-boxes and wearing away at the bottom. We finally went to copper, and then returned to steel, and we have no trouble now. I don't know as I have heard of a cracked fire-box now for some years.

MR. H. N. SPRAGUE—I think that we will find that that is largely the trouble that has been experienced with steel fire-boxes—that until quite recently we had not got the proper grade of steel for fire-boxes. We want a thoroughly homogeneous metal. I think we are getting that now in our fire-box steel. The less carbon in it probably the better.

MR. JACOB JOHANN—So far as we are concerned, we have some portion of the road on which the water is very bad, especially in precipitating lime. But we do not have any of those difficulties now of cracking inside sheets. In anywhere from eight to twelve months it will form such a scale on the flues that we have to take them out and clean them off, but we never had any trouble with the inside sheets. Sometimes the crown sheet gets scaled so that it don't keep cool, and we have to take that off. I have not lost a side sheet from any of our six hundred engines, and I have attributed it more to our mode of firing than anything else. Lime water don't seem to have the effect that we all attributed to it some time ago. On the inside sheet when it gets a little thick we knock it off by using powerful pressure and by washing it and so on. Speaking now about the grades of steel, Mr. Hewitt, of St. Louis, is present, and I think he can corroborate me in the statement that in 1869 or 1871 their equipment was entirely rebuilt. They had copper fire-boxes. They were all changed to steel. Those fire-boxes were built from Park Brothers' Steel, and Hussey, Howe & Co.'s steel, and I frequently remarked—although I have not had charge of those engines for some years—that those fire-boxes had done about as faithful a service as any boilers that I ever saw. I think I am safe in saying that you have not renewed one-half of those fire-boxes yet.

MR. HEWITT—No, sir; some of them are yet in good order.

MR. JACOB JOHANN—This information that we are bringing out is most valuable. I hope the members present who have any experience of that kind will state it. I would like to ask Mr. Hewitt how many engines he has on his road with steel fire-boxes.

MR. HEWITT—About all. I don't know of any iron ones. We have had some trouble with cracking, but at the same time we have a great many steel fire-boxes in fair condition yet. Of course, you can under-

stand what their condition must be after fifteen years' service, but they are still in existence and have not given any indication of requiring new fire-boxes immediately.

MR. M. N. FORNEY—Could you say what proportion of the steel fire-boxes did crack?

MR. HEWITT—Twenty per cent. I should say—perhaps not so much as that. While on that subject I would say that while Mr. Johann was there he built a stationary locomotive boiler. He bought the material for two but only built one. After two years and a half of service, using the lime water that we have at the works, that fire-box was destroyed. It was cracked all over, from the stay-bolts all around, and we had to throw it out and put in a new one. In doing so we used the sheets of the other boiler for the new box, and we commenced to use the Mississippi River water from the city water works with the new fire-box. That is now about ten years ago, and apparently the present fire-box is as good as new. The difference was that with the lime water the plates were coated with the lime and not accessible to the water, and the plates were destroyed. With the good soft water the fire-box, after ten years' service, is in excellent condition.

MR. M. N. FORNEY—Were the plates of the same make in each case?

MR. HEWITT—That Mr. Johann can tell.

MR. JACOB JOHANN—Yes, sir.

MR. M. N. FORNEY—That indicates that the lime water cracked the plates, and is valuable information.

MR. JACOB JOHANN—The only way we could run our locomotives was not to use that water permanently. Lime was all that was in the water; nothing else gave us the trouble.

MR. B. WARREN—I have had some experience in that direction also.

MR. JACOB JOHANN—Mr. Warren was also cognizant of this, as he was there in 1868 and 1869, and practically commenced the operation. I was intermediate, and Mr. Hewitt came there subsequently.

MR. B. WARREN—There were 46 fire-boxes for these engines ordered from Hussey, Howe & Co., in 1868. These were the ones that Mr. Hewitt and Mr. Johann spoke about. As regards the bad water on different divisions, I have on some of my divisions hard water where our fire-box will not stand—when composed of the best of steel—over two years and a half. The steel of a low grade will commence cracking at the stay bolts an eighth at a time, and you must plug them up. With the higher grade of steel it will go sometimes two foot at a time. Then we have to patch. Now, my opinion is that the difference in water has a great deal to do with it; also, the grade of steel. I have also had ex-

perience with iron fire-boxes, with soft water, which have done well enough, but no better than the steel. The objection to iron is the blistering. They will blister and sometimes come off, and sometimes run through. They are not as liable to crack as steel. I think that hard water has a great deal to do with the cracking of steel fire-boxes, and I think the lower grade of steel is much the better.

MR. J. N. LAUDER—There is one detail of construction that I would like to urge strongly upon the members of this Association—something that I think has never been done; if it has, it has been done recently, and to a limited extent. That is putting a mud ring at the bottom of the furnace, deep enough to admit of putting in two rows of rivets—double rivet the mud ring. Ordinarily it is made of iron, bent end-ways. That allows of one row of rivets; and it makes a very weak job. There is an immense strain there. The consequence is, leaky corners all the time. I think, if that ring was made, instead of two inches deep, three and a half to four inches, deep enough to get in two solid rows of rivets, that it would cure that in a great measure. I am doing it now. Of course I have not had experience enough with it to know whether it will be a paying investment or not. I think any man will readily see that it must, to a certain degree, cure this difficulty of leaky corners.

MR. J. P. HOVEY—I think Mr. Lauder's suggestion is a good one. No doubt there are leaky corners, from the fact that it is almost impossible to get a sheet to fit nicely around the corners, so as to be held with the rivets coming, not through, but part way. With a double rivet we have the advantage of two half rivets in place of one. I think the suggestion is a very good one.

SECRETARY SETCHEL—This discussion is very interesting to me, but I don't want the members to think that I am advocating steel in preference to iron. I can assure the members that I would talk but very little if I could be sure that every one of our locomotives could be supplied with soft water; because then I am sure that an iron or steel fire box would last any length of time. On the Ohio & Mississippi R. R., with which I am now connected, twelve years ago they purchased from the Baldwin works 40 locomotives, and from the Grant works 10. They were placed on the road, and from that time until this I suppose they have averaged 4,000 miles a month—each engine—constantly. These engines, up to within the last 18 months, have had none of their fire boxes renewed. The average life of those engines has been 12 years. That, to my mind, is a complete demonstration of what good water will do for steel, and I think it will do equally well for iron.

MR. H. N. SPRAGUE—I suppose there are some advantages in steel.

Another point is that we can get steel fire-boxes as cheap as we can get good first-class iron ones. I presume the iron—good iron—is as high as steel to-day. Another advantage in steel is, that it holds its shape better than iron. My experience has been with the lowest grades of steel, that it seems to stand riveting as well as iron, and still holds its shape better. It is stiffer.

MR. J. P. HOVEY—There are various opinions in relation to steel and iron. We have many elements to contend with. For instance, one man has better coal than another; another has pure water. Now, both of these things exert an influence upon the fire-box. In 1857, I got 15 locomotives from the Baldwin works with the fire-boxes made of Sligo Iron. Those engines ran about two years and then some of the fire-boxes failed. I cut out a piece of a fire-box from one of those engines and sent it back to the Baldwin works. It was about as hard as steel. It had become carbonized by the coal we used. He returned the plate to me after annealing it. You could turn that plate right over as tough as any boiler plate you ever saw, notwithstanding it was as hard as glass when taken out. Therefore, you have the different elements to contend with. So far as steel is concerned, I have had excellent success—never having been bothered much. Once in a while we get a plate that will crack from the stay bolts out; but it is very seldom.

MR. J. S. PORTER—About three years and a half ago, on one of our engines, number 123, I put in a fire-box. In the left hand side I put in a sheet of Sligo Iron. On the right hand side I put in steel, and I found that the steel was the best; we had several cracks in the Sligo iron side.

MR. J. D. BARNETT—With what fuel?

MR. J. S. PORTER—Soft coal.

MR. CHAS. BLACKWELL—On our road we have very bad water, the quantity of solid matter in it varying from 15 to 25 grains to the gallon, and we have a great deal of trouble with cracked fire-boxes—both iron and steel. Some engines built by the Baldwin Company, some two or three years ago, were supplied with a certain brand of iron that was tested by the general manager of the road. Those engines ran for various periods before the first crack appeared, varying from 4 months to 12 months. I believe that the chemical composition of the material has a great deal to do with it. We have a great many other fire-boxes on the road made of other brands of iron that have been running three or four times as long with no signs of fracture. I believe also that the quantity of sulphur in the fuel has a great deal to do with the cracked fire-box. After the sheet on the water space side has become more or

less coated with scale, it becomes more highly heated than when the water has direct access to it, and I believe it absorbs more sulphur from the coal than at a lower temperature. In fact, I have testimony to prove this by having a chemical analysis made of strips of iron cut from near the foundation ring and up in proximity to the crack. I found that there was from two to three times the quantity of sulphur in the iron, in proximity to the crack, than elsewhere. I think, therefore, that coal with a large excess of sulphur should, if possible, be avoided as fuel.

THE PRESIDENT—This is an interesting subject, and we will be glad to hear from all members. There are many who have said nothing so far, and we shall be glad to hear from them.

MR. ANGUS SINCLAIR—I would like to say a word on that first question of Mr. Forney's, about the condition of the water in England and in this country. I have had some considerable experience in both countries, and have paid very great attention to the subject of hard water. I don't think there is any road in England that uses water so hard as many of our western roads, and they are using steel fire-boxes successfully. So I do not think that the water question can explain the failure of steel in English fire-boxes. I think probably that the high grade of carbon in the steel used had a great deal to do with it, and also the working. I think it is probable that their workmen did not get into the way of annealing the sheets properly before putting them into the fire-boxes. That would be likely to lead to failures. All of you know how often failures occurred when steel was first tried in this country, and in many instances it was attributable to unskillful working; that is, through insufficient care having been taken in annealing. I think, to work their steel successfully, they should have men who are accustomed to the working of it. I think it is probable that they can produce just as good steel as we can, if that is done. It is merely a matter of experience. They evidently became discouraged too quickly, and gave up the use of steel without giving it a proper trial. Hard water certainly has an injurious effect on fire-boxes, and steel that will stand with good clean water will not stand with hard water. On the B., C. R. & N. R. R., Mr. Bushnell knows how difficult they found it to get fire-boxes to stand the hard water used by them at Burlington. It was a water containing a very high percentage of sulphate of lime. Finally they took water from the Mississippi River, and they have had the best of success with their engines since that time. I do not think that they have had any trouble with fire-boxes since they have used that water.

MR. JACOB JOHANN—Speaking on the question of annealing, I want

to say that I abandoned that some years ago. Originally we thought it necessary to anneal all the sheets, and we gradually came to the conclusion that we were not getting the benefit out of it that we expected, and so we abandoned it. For the last six years we have not annealed a sheet. As a matter of course we insist upon our men being careful in handling the steel. We do not allow them in straightening a sheet to use a hammer. We found that where we would use a hammer, that wherever there was a blow struck the sheets were indented, and therefore we positively prohibited the use of a hammer in striking a sheet, and we now use a wooden maul, or a flattener, that sits right square on the surface, and we pound upon that. I cannot agree with the authorities that recommend annealing. I have never had any better results from annealing than I am having now. It is the same way with the rivet holes. Some people advocate that it is necessary to drill steel. I have no doubt it is, but it takes more labor. What we aim at is to reduce our labor to the minimum, where we can get just as satisfactory results. We do not drill; we punch. Of course we watch the men and we do not allow them to drift. We make them limit themselves.

MR. H. N. SPRAGUE—I am careful not to work flanges down cold. I think when steel is worked down until it is cold it is likely to cause a little hardening there. In the corner flanges, where we have to work them until they appear cold, we heat them and let them cool themselves.

MR. JACOB JOHANN—I think there is no doubt that the better the water the less expense in maintaining boilers, and I have not the least doubt that our western roads, if they would direct their attention to purifying their water, or getting better water, or putting in reservoirs, would more than save the expense in their boiler repairs. Boiler repairs are the most expensive items in maintaining machinery. On certain portions of our road we cannot run our flues over six months. In that time there is no remedy but to take them out and clean them and put them back again. On other portions of the road we are greatly bothered with mud sediments. Some years ago we used to insist continually upon the engineers blowing out their boilers frequently, but that was partially lost sight of. Of late I have commenced that system again. And we are just re-arranging our boilers in order to blow out from the cylinder part, and we insist upon the engineers doing that four or five times a day. But after all, the difficulty is with the water. If the water was pure we could maintain our boilers better.

MR. WARREN—I am satisfied that the water has more to do with the steel fire-box than anything else. Take our flues, for instance. On one

of our divisions we will have to commence tightening up the first week after being renewed, where the engine is running at one end of the division, but if we put that engine at the other end of the division, it will run three or four years without having to be touched. So that shows that the trouble is with the water—there being a great difference in the water on the two divisions.

MR. M. N. FORNEY—This discussion has called out a very important fact, and that is that lime water is particularly injurious to steel fire-boxes. There is one other gentleman whose testimony I would like to hear, and I am sure the rest of us would. That is from our old President, Mr. Britton.

MR. H. M. BRITTON—I don't know as I can throw any further light on the subject. My opinion has been for many years that lime water was a serious objection and obstacle which we had to overcome in all kinds of sheets for boilers—whether iron or steel. Many years ago I was in the West where we had nothing but lime water, and, as I heard some one say this morning, in a very few months the flues had to be taken out, and very soon after, the fire-box crown sheets and side sheets; in fact, in a short time after the new engine went out I have seen the crown sheets so full and hard to the top of the crown bars, that it was necessary to use a chisel and a hammer to remove it. My theory has been to get pure water with a low grade of sheets, and you would have good fire-boxes.

MR. H. N. SPRAGUE—I would like to ask whether any of the western men have given up the plan which they had under consideration, of getting pure water to put in their boilers. Several years ago there was a great deal of talk of purifying the water with chemicals, and I thought they were going to revolutionize the water business in the West. I would like to inquire whether they have abandoned that.

MR. JACOB JOHANN—I don't know that the idea has been abandoned, but I know there has been a failure on the part of the railroad companies to furnish any money with which to endeavor to get better water. I do not think that any of our Western members have abandoned the idea.

MR. H. N. SPRAGUE—That is what I wanted to know—whether there had appeared any practical solution of the question.

MR. JACOB JOHANN—Once in a while the companies will give us a lift here and there, and, in the course of time, we will possibly arrive at that very desirable result.

MR. F. M. WILDER—Our road is blessed with good water. Of course we have to make new wells, but since our road has come in close rela-

tions with the N. Y., P. & O., I have had occasion to examine their water. Mr. Fuller sent me several samples of water from the different tanks on his line for analysis. My recollection is that in some of the water, which was perfectly clear, there was as high, perhaps, as 42 grains of solids to the gallon. I would like to hear from him more about that, as he did not give us any data excepting a letter stating that each one of the samples was numbered, etc. I would like to hear from him as to where those samples were taken from, and how they were obtained.

MR. WM. FULLER—I think the worst water which we have is pumped from streams on the line. In some cases we are troubled very much with water taken from the wells. In our practice we are not able to run steel fire boxes over about five years before we have to remove them, on account of the sheets being destroyed by bad water and bad coal. My impression is that not all the trouble is from bad water. I think the character of coal has a great deal to do with the destruction of fire boxes. As Mr. Wilder remarked, we have several points on the line of our road where the solids in the water amount to 42 grains to the gallon, but we are now trying to remedy that by using surface water. There are some streams on the third and fourth divisions which are very highly impregnated with lime, and we have a great deal of trouble with it.

MR. CHAS. BLACKWELL—Has any member here present been successful in using any of the so-called boiler compounds for preventing deposits of solid matter in boilers? There are a great many compounds sold, all said to attain this end. I would like to hear of any parties who have successfully tried any of these compounds, and, if so, to name them.

MR. H. N. SPRAGUE—I am using a compound in my stationary boiler for driving engines and hammers, and for heating our shops. It is a 60 shell boiler. I am using a compound made by some man in Boston, with reference to counteracting the chemicals in that particular class of water. He don't claim to make a compound to suit the water of all localities. He takes the water of the Allegheny River and analyzes it, and makes a compound for that. I am using it with very good results. Of course our water is not bad, but I find without using anything at all we have some difficulty. This compound I pump into the boilers—a small amount every day. I don't believe it would be effective in a locomotive boiler, with the small water spaces which they have.

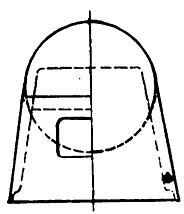
MR. CHAS. BLACKWELL—Has any injury been discovered to the boiler from the use of that material?

MR. H. N. SPRAGUE—No. It is simply a quiet purgative operating

Boiler for Passenger Locomotive No. 28 Camden and Amboy R. R.

Designed for burning Anthracite Coal by Isaac Dripps in 1848.

No. 28 had a single pair of Driving Wheels 8' diameter Cylinders 13" diameter by 34" Stroke.



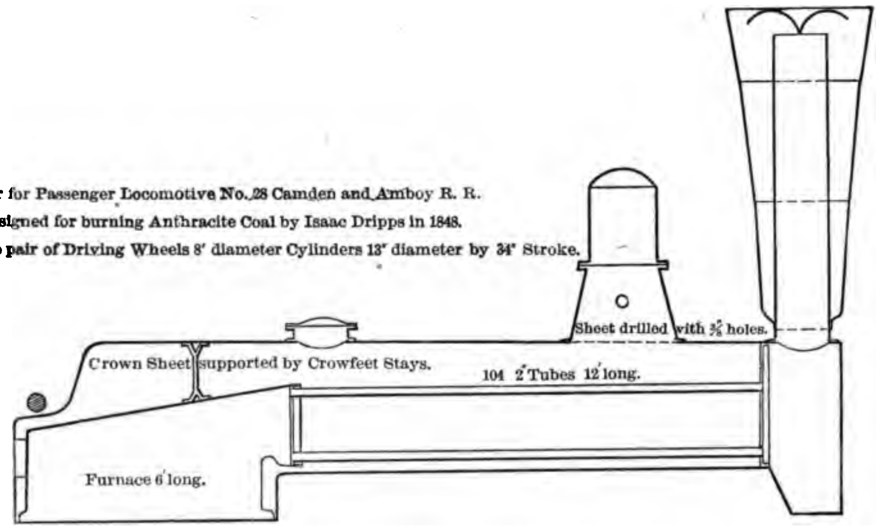


Plate No. 28 F.

Boiler for Freight Locomotive—Monster Class—of the C. & A. R. R.

Built at the Trenton Locomotive Works in 1852.

Designed for burning Anthracite by Isaac Dripps.

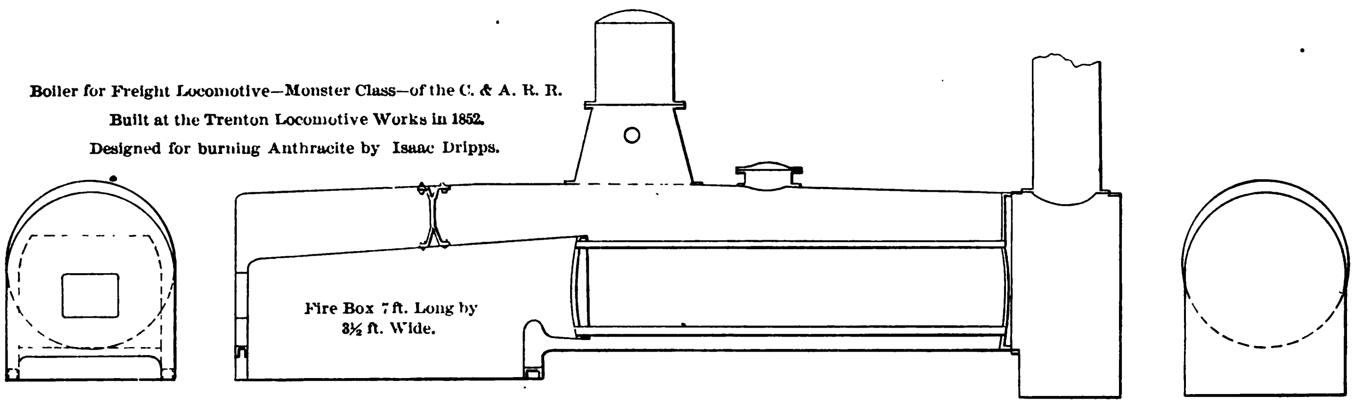


Plate No. 28 G.

ring at the base of the dome. In this country it is not so. I think if any body would look into that subject, they would see that by that method you do not come anywhere near restoring the strength of the plate which is taken away by cutting a hole into it. It is a terribly weak portion of our locomotive boilers. A short time ago I was talking with Mr. Hain, the Superintendent of the New York Elevated Railroad, and he told me that he had been having a great deal of trouble from the cracking of the plates around the dome opening. The plates cracked about the opening, and the boilers then gave way; and I have no doubt that a great many explosions are due to that cause.

MR. F. M. WILDER—Our practice has been, and is, similar to this practice that Mr. Forney condemns flanging up the sheet, and setting the dome sheet down on the boiler, and putting in two rows of rivets, with a row through the cylinder part of the dome. But we have never had any trouble with any of our sheets giving out there at all. With the boilers built within the last two or three years, which are all steel boilers, they are all made in that way. We take a good deal of pains in regard to staying down to the crown bars. We get the number of stays we put in now, but when we lay down a boiler parallel to the sheet of the dome and fasten it to the crown bars, we are also particular in the number of stays we put in from the wagon top down to the crown bars. We have them in every space of six inches square. As I said, we have had no case of any of our dome sheets or our wagon top sheets cracking, and only two instances, with a steel boiler, where we have had a sheet crack, and that was on the long longitudinal seam where the wagon plate comes down and is joined to the side sheet of the outside of the fire-box, and we braced that, because we found it was going to cause some of the horizontal stays that run from side to side to become loose. That is the only instance that has come to my attention in some years.

MR. JACOB JOHANN—I have not had any such experience as Mr. Forney speaks of. My practice is simply like that of Mr. Wilder. I rather favor flanging the wagon top sheet up, because you have that large opening there, and you stiffen the crown of the wagon top by doing so. In my opinion that makes ample security for the dome, and, in addition, as Mr. Wilder says, we use those vertical stays down on the crown bars. We use a 28-inch dome, and we have not any trouble with them, and so we do not look for any improvement in the matter. I believe those points generally bring about improvement if they do not work. So long as everything is satisfactory we are disposed to let them go.

MR. ANGUS SINCLAIR—I had an opportunity of seeing the working of

that case, which Mr. Forney refers to, pretty closely. I don't think that the practice of vertical stays would help it any. It was found on the Elevated Railroad engines that they had a good deal of trouble with leakage around the dome base. They stripped one of the boilers and put up appliances for taking very accurate measurements with it. Then they set this appliance for taking the measurements both side-ways and vertically when the engine was cold. Then they raised steam, and they found that when the pressure was on the boiler, the dome went down and the boiler became wider horizontally. The tendency of the pressure was to make the boiler oval, and it was putting a tremendous strain on the dome base in some way, and was continually causing leakage. They tried that several times to see that they were making no mistake with it, and they became satisfied that this was the effect that pressure had on the boiler. They inferred from that that the boiler was too weak at the dome opening. So they commenced putting on a strong strengthening ring around it. They tried the same experiments on two occasions, and there was no deflection to speak of. In consequence of this they adopted the practice of putting on these strengthening rings, and they have never had any trouble with leakage since. You will see from that, gentlemen, that the tendency of the boiler would be to slack those vertical stays, since the dome went downward when the pressure came on to it.

MR. JACOB JOHANN—I would infer, however, that there was not sufficient lateral staying, which caused a tendency to extend sideways, and therefore to pull the crown down; that in all probability immediately above their side stay bolts they had a flat surface that extended up beyond that, which was not sufficiently stayed, and that pressed out, and, as a matter of course, drew the crown down. I would infer that they would probably have accomplished the same result by putting in some more lateral stays to keep the boiler in shape.

MR. AUSTIN—I am not a member of this Association, Mr. President, but if you will allow me to speak I think I can throw a little light on the subject under discussion. I am from the Baldwin Locomotive Works. In regard to those New York elevated engines, I desire to say that I have seen those domes, having had occasion to go over there several times to examine them. I think the trouble was that they were not made right. Those boilers were made too thin. They were made at a time when the elevated road was very particular to cut off every inch in weight, and the company insisted that they should be made only one-quarter of an inch thick. These domes were 19 inches, boilers 34, and flanged down on the shell. I saw some of those domes after they were taken off, and in

the flange they were only five thirty-seconds of an inch thick—some of them three-sixteenths. They were so thin that they were not able to stand. Quite a number of them were cracked around the rivet holes. They gave way because they were too thin, which was done to save weight. After that we insisted on making those boilers thick enough to stand the flanging. The fact of flanging the boiler up into the dome, and the dome down on to the boiler—that way of doing it is no trouble when the plates are made heavy enough to stand the waste of flanging.

MR. F. M. WILDER—Were those plates flanged up into the dome, as well as the dome being flanged down on to the wagon top sheet?

MR. AUSTIN—Yes, sir; they were.

The tenth, eleventh and twelfth propositions contained in the report were then read by the Secretary.

SECRETARY SETCHEL—The abandonment of the braces from the back head to the frame, it seems to me is wrong. While they are not necessary to the working of the engine or maintaining the engine while in use, still I think when you come to jack up an engine in the shop it does seem to me highly necessary that they should have back braces so as to prevent bending of the frame. I have never yet seen frames so large that this would not take place to a certain extent. You cannot take out the wheels without taking off the binders, and that leaves the frame weak and liable to bend.

The Secretary then read the thirteenth and fourteenth propositions contained in the report.

MR. H. N. SPRAGUE—I would like to be able to say that mud drums are out of practice so that I would not have to put them in, but every once in a while I get an order from a Western man who insists on their being put in.

MR. JACOB JOHANN—I don't think it is the general practice, but I think it is tending in the direction that we find that the mud drums are a useless appendage. In my operations I cut them all off, and simply rivet a casting on the bottom of the cylinder part of the boiler that has a sort of depression, so as to be more ship-shape, in which I screw the blow-off cock, so that in blowing out it does not run on to the engine but under. We find that in that way we fully accomplish what we originally hoped to accomplish with the mud drum. The mud drum carries about so much mud all the time, but does not do anything else, in my opinion. For some years I have abandoned them, and as fast as we rebuilt boilers we cut them off and put this other arrangement on, which does not take up nor obstruct the lower portion of the boiler.

SECRETARY SETCHEL—The practice of blowing off engines under full

pressure I object to. I believe that more scale will be deposited in the boiler in that way than by any other method. The proper way to do, is to let the engine cool down until the pressure with which you fill your engines will work against the pressure in the boiler, and then put on your hose and let the water run down until the boiler is cool. But if you blow the boiler out under full pressure, there will be a film gathered on every part that you cannot wash out in any possible manner.

MR. F. M. WILDER—I fully agree with Mr. Setchel in regard to the m nner of washing out by blowing off boilers. It has been our practice to let down the pressure by letting up the scales until the hydrant pressure would force the water in, put the hose on, and open the blow-off cock, so that the water would keep the same level in the boiler. The contraction of the boiler, being hot from the heat while under steam down to the temperature of the water, is done gradually and even all through, so that there are no sheets strained unduly by the temperature suddenly being changed. The whole process is gradual. I also agree with him in regard to the effect of the sediment being burned on to the flues and all other parts of the boiler, by letting them blow out while the steam is still on.

The fifteenth proposition contained in the report was then read by the Secretary.

SECRETARY SETCHEL—That is the last of the propositions, which the committee report as being generally agreed upon by master mechanics.

MR. J. N. LAUDER—I don't think we ought to let that subject drop without a little discussion. I have become thoroughly convinced that in order to get the full efficiency of the locomotives of to-day we must increase our pressure. I have got up already, in my mind, to 175 pounds. I believe we ought to carry at least 175 pounds maximum pressure in order to get the full efficiency of a modern locomotive. The introduction of steel rails and tires has made it possible to use enormously heavy engines, and now we want to get weight. Some of us are putting in heavy ash pans for the purpose of getting weight; some engines are being built with large blocks of cast iron placed on the sides of the fire-box in order to get weight. That being the case we want to put more weight into the boiler. We can make that as strong and heavy as we please. There being no difficulty in getting boilers that will hold these high pressures, I think it will be found economical in all cases to use our steam at much higher pressures than heretofore.

(The Secretary then read the first of the propositions, which the report says are not generally agreed upon.)

SECRETARY SETCHEL—I should be glad to hear from Mr. Austin, of the Baldwin Locomotive Works, upon this:

MR. AUSTIN—I have never been able to reconcile the opinion of so many that I hear from, in regard to the diameter of flues. Sometimes when I hear a couple of dozen men from different parts of the country all speaking or writing on the same subject, I find by comparing notes that they all disagree with each other. Yesterday, in talking with some gentlemen, one man praised up one thing, and said he had had no trouble with it for 20 years ; another man could not get along with it at all under the same condition. Sometimes the reason that is given seems very vague. I must confess that I am unable to give a clear opinion upon the question.

MR. J. N. LAUDER—I don't think this question of diameter of flues need to trouble us very much. Forty years' experience with the locomotive by men all over the world has gradually brought us to about one thing in the matter of flues. Flues have been tried all the way from one and a half inches diameter to three inches, and the practice has gradually grown down to a sort of standard of two inches, external diameter. What has brought that about? Undoubtedly the experience of men in experimenting with these different kinds of flues. I believe in the survival of the fittest, and I think the fittest in this case is the two inch flue. With few exceptions the two inch flue has held its own against all others. I am aware that in England and on the continent of Europe they use a much smaller flue than we do here. I can not account for it. Their experience has led them to that conclusion. The Pennsylvania Railroad, which is acknowledged to be as bright and wide-awake theoretically and practically as any railroad in this country, has shown a tendency to use a larger flue than two inches. Possibly the results attained are due to the difference in fuel—possibly to the material of the flue. In England I think they use a brass flue, while we use iron. The happy mean is two inches, and I propose to continue it until I see some objection.

MR. AUSTIN—Our own opinion in regard to the diameter of flues is this : we make the diameter of the flue larger as the length increases. We do this for two reasons: First, because the longer the flue the weaker it is to support itself; and second, when you come to flues in the neighborhood of 12 feet long they are increased at two and a quarter and sometimes two and a half. Short flues are made one and a half inches. Of course we are making more different lengths of flues than the majority here are. The longer the flue the more liable it is to choke the flame. If it is increased in proportion to its length, besides giving the strength, we have a greater amount of air, and a less liability of choking up.

MR. H. N. SPRAGUE—It seems to me that we have got to proportion the diameter of the flue to its length. My impression is that the English flue is shorter than ours.

MR. J. N. LAUDER—In discussing these matters I take it for granted that we are discussing the ordinary gauge engine—flues varying from 11 to 12 feet. I think if we are going to build a narrow gauge engine, we should put in, of course, a smaller flue; but I take it for granted we are discussing an engine that runs on the four foot, eight and a half inch track. In England, their flues, in large engines, are some of them 14 feet long. I think in their practice, however, a smaller flue than we use here is used.

MR. JACOB JOHANN—I think Mr. Austin's explanation is entirely correct, and since Mr. Sprague and Mr. Lauder have referred to narrow gauged engines, it has reminded me that we had several narrow gauge engines that had one and a half inch flues and were, I think, eight feet long. But we could not do much with them, and we finally took the flues out and put two inch flues in. Since then we have had no trouble.

MR. R. C. BLACKALL—I would like to inquire from those who are using one and a half inch flues if they have any difficulty in keeping them as tight as the two inch?

MR. H. N. SPRAGUE—I am aware that this Convention is a Convention of Master Mechanics, and that no one is here to set forth the particular merits of the articles of his own manufacture. We do not use any long flues. I believe we do not build an engine with a flue ten feet long.

MR. F. M. WILDER—We have a narrow gauge road in connection with our line, and we do the repairing of locomotives on it. Recently we have had to put all those narrow gauge engines through the shop, and I found in two instances, of engines built by the Baldwin works, that they had one and a half inch flues. They never could do much with these engines. We have now put in new flue sheets and are putting in two-inch flues instead of one and a half.

MR. JACOB JOHANN—I am a little fearful that Mr. Sprague misunderstood me. I did not intend to say anything personal in regard to narrow gauge engines. The flues depend very largely upon the fuel used. In the fuel that we have got, we cannot use a small flue. With a small flue we choke up, and we have, therefore, to enlarge them. I certainly esteem Mr. Sprague too highly to say anything personal.

MR. H. N. SPRAGUE—We use three sizes of flues: one and a half, one and three-quarters, and two inch. For the first size, up to five feet;

and then, of the second, up to nine feet; and, from eight to nine and a half feet, we use two inch flues.

MR. CHAS. BLACKWELL—We have quite a number of ten wheel engines, having tubes of that diameter, 12 feet 6 inches, and a trifle over. Engines of that size of tubes are the best.

The Secretary then read the second proposition in the report, of the class which the report stated was not generally agreed upon.

THE PRESIDENT—I think, perhaps, it is necessary to make an explanation, inasmuch as the committee seem to have been quoting me. If I remember correctly, the committee has not fairly stated what I said; that is, they have left out a portion. I believe I said the grate should be as small as possible to burn the requisite amount of fuel to do the work you wanted. The committee seem to have only got a part of the statement. If I did not say that, that is what I intended to say.

The Secretary then read the third, fourth and fifth propositions in the report, in relation to which the mechanical world is not generally agreed.

MR. F. M. WILDER—For the last three years I have stopped building anything except an anthracite fire-box. We are using, for burning soft coal, a box nine feet six inches on the inside, for the shortest; and for our large consolidation engine, ten feet long. We are using those engines in any service called for, with either kind of coal, and I know that the results we get in burning soft coal with those long fire-boxes. are better than with the short ones. We have the additional advantage of having a much greater amount of fire-box heating surface. Instead of 99 feet we get as high as 140 to 155 feet of fire-box heating surface. The result so far has been that I have stopped building any other than long fire-boxes.

MR. CHAS. BLACKWELL—Fire-boxes such as Mr. Wilder has described, are being used on the engines on the North-western & Shenandoah Valley Railroad. The fire-boxes are 102 inches in length, and we have obtained as much as from 9 to 10 pounds of water evaporated to a pound of coal. I think that is pretty difficult to beat with most engines.

MR. H. N. SPRAGUE—I don't think it is possible to get the fire-box too large. The fire-box heating surface is the best heating surface you can get without doubt.

The Secretary then read the fifth and sixth propositions in the report, about which the mechanical world disagree.

MR. J. P. HOVEY—I would like to hear from Mr. Wilder about this. Several years ago I tried the experiment, but was not successful. Mr. Wilder is using a great many.

MR F. M. WILDER—I had not expected to say anything on that subject. As Mr. Hovey says, we are using a great many of them, but I am not yet of the opinion that we have got the right thing in fire-box arches. Possibly with the use of brick arches we have less smoke. Possibly it is because our men are more careful in their way of firing the engine. The design that we have used is one that is not novel; it is simply a heavy fire-brick, six inches thick and suspended by a water tube screwed into the crown sheet and also into the front sheet below the flues; with the admission of air through three, or four, or five two-inch holes under the brick, open all the time. We have also tried to introduce a steam jet from the front ends, together with the air. I am not able to say now that we can show any good results from statistics that that is a benefit. I am satisfied that with the long fire-box we get enough better result from our fuel over the other that we will probably not build any more short fire-boxes.

The Secretary then read the seventh proposition.

SECRETARY SETCHEL—I want to say in regard to that, that I do not think it is practicable to use the water tubes upon any road where they have impure water. I believe the tubes were first used upon the Philadelphia & Erie and Pennsylvania Central with entire success, but I have never seen a road where they have impure water where they would run any length of time. Even if that were the case it seems to me that it is wrong in principle, If, as is claimed for these tubes, there is a continual circulation of water through the tube from the bottom to the top, it seems to me it is from a point where the very dirtiest water is to be had, and when that water is carried to the top of the crown sheet and deposited there, it seems to me to be all wrong. Whether that is a fact or not remains to be seen hereafter. I know that wherever those tubes have been put in, and the water is hard, that they give out in a very short time. It seems to be a much preferred plan to put angle iron on the sides of the fire-box and support the bricks by the arch. It is less expensive, and if they give out on the road it does not delay trains and it costs only about one-third of what it does to put them in on tubes.

MR T. J. HATSWELL—We use the arch and water tubes. The first engine we put it in has run 40,000 miles, and we have the same arch and some of the tubes that we first put in. In some other engines the tubes burned out in six months. As for the collection of mud on the crown sheet, I want to say that the crown sheets are cleaner with the circulating tubes in. I much prefer them to the angle iron because I think it keeps the sides of the sheets cold,—by using the tubes it leaves a space of an inch between the end of the brick and the sides of the fire-box.

SECRETARY SETCHEL—Would you not think it wrong in theory to carry the sediment to the top of the crown sheet?

MR. T. J. HATSWELL—That is a point that I anticipated at the time, but I opened the dome last week and found the crown sheet just as clean as when the engine came out of the shop. I was surprised. I fully expected to see a deposit on the top of the crown sheet.

MR. J. H. FLYNN—I had come to the conclusion to say nothing but to learn all I could; but when it comes to the brick arch I have got to say something. I contend that there is no benefit in it, only it compels a fireman to fire his engine right. While we cannot educate the firemen to fire the same with the open fire-box as with the brick arch is a mystery to me. I have educated my firemen to fire in that way. I know the brick arch is expensive. Every new coal burning engine comes with a brick arch, and after running them awhile the engineers beg me to take them out. I have taken some of them out and run the others to see if there was any benefit in the consumption of fuel; but there is none whatever. With the kind of coal we use the brick arch only lasts three or four months and then has to be renewed; with a passenger engine probably five or six months. If you cannot control your firemen then I am willing to acknowledge the good of it. Some engineers will burn double the amount of coal that others will, because they are using too deep a fire—they are consuming fuel that they get no advantage of. If it can be demonstrated to me by those who have been accustomed to using a brick arch for years where the benefits are, then I am willing to acknowledge that I am wrong.

MR. T. J. HATSWELL—We find a great saving in regard to leaky flues since we adopted the brick arch. We had an engine running on the west end of our road whose flues were all leaking. Last fall we put a brick arch in, and that engine has run since without leaking. We don't claim any saving in the fuel.

The Secretary then read the eighth proposition in the report.

MR. J. N. LAUDER—I would ask to have that description relating to boiler tests read. I do it for this reason: we have a law in Massachusetts that requires us to follow a certain process in making boiler tests. When that question was up I neglecled to say a word, and so I would like to have it read again.

The Secretary then read the section referred to.

MR. J. N. LAUDER—I would move now that the discussion upon this question be closed.

Mr. H. N. SPRAGUE—Second the motion.

Carried.

THE PRESIDENT—The hour has now arrived for the discussion of such questions as may be handed in by the members. Previous to that, however, I wish to announce the committees: Committee on Subject for Investigation, James Boon, John H. Flynn and George Richards; Committee on Assessment, H. L. Cooper, John S. Cook and Chas. Graham; Auditing Committee, James P. Gordon, J. N. Lauder, T. B. Twombly; Committee on Nominations of Officers, J. N. Lauder, J. F. Devine and Allen Cook; Committee on Resolutions, F. B. Miles, Willard A. Smith and Angus Sinclair; Committee on Next Place of Meeting, John H. Flynn, George Hackney and A. G. Eastman. Obituary Committees, in the case of John McFarland, T. L. Chapman, James Meehan and R. H. Briggs; in the case of Charles A. Smith, J. Johann, John Hewitt and H. M. Smith.

A recess of five minutes was then taken for the purpose of enabling members to pay dues.

The discussion of questions proposed by members being next in order, Mr. A. G. Eastman submitted a question:

Should we not protect the outside of our locomotive fire boxes with some covering or jacket to give at least a dead air space?

MR. A. G. EASTMAN—We have 100 square feet, more or less, on our fire boxes, out of sight, unprotected from the weather. It is down next to the ground, and it seems to me we loose a great deal of heat. I think there should be a thin sheet iron covering to the fire-box, even if we do not get more than one-quarter or one-half inch thick between it and the fire-box. It is a subject that I never have experimented on at all, but really it seems as though that part of the boiler should be protected.

There being no discussion the Secretary offered the following:

I believe it is decided by the injector men, that in order to secure the best service from the use of injectors, as well as to increase their durability, that there should be an oil cup placed either in the steam pipe or the water pipe. The question I propose is: Where is the proper place for the position of an oil cup for oiling the injector? Some claim that it should be placed upon the water pipe; others claim that it should be placed in the steam space. If the first is adopted, it seems to me that with the first overflow from the injector the oil will all go out, and your steam valves will not get any benefit. If you place it in the steam pipe the question is then: Do the water valves derive any benefit from it? It is a practice with some to place a pipe from the foot board to the feed pipe. Now, where is the proper place?

MR. ANGUS SINCLAIR—Some years ago I was running an engine with

an injector. The water used was exceedingly hard. Finally we had difficulty in starting the injector. I examined and found that the movable piston inside of the injector was obstructed from a scale that formed inside of the shell. I had a small plug put in the steam pipe to the injector, and put a little common black oil upon it. That cut away the scale, and there was then no difficulty in working the injector. If I would let it go for a few weeks without doing that I would have the same trouble in starting it. At the same time I tried the common cylinder oil, also tallow, but I found the common black oil, such as used on the ordinary part of the machinery, was the best. I think the steam pipe would be the best place to put it, because you can give it a little steam and blow the oil into the injector, and it will not be lost, whereas if you put it into the water it is almost certain to be lost. If you have it so, you can feed when the injector is working, and feed it after the water is going through; after it has ceased to go through the overflow, then it will go inside of the injector, but will go through so quickly that I don't think you will get the benefit of it inside the injector, as it is there that it is needed. It may have some effect in loosening the scale around the check valve and about the pipe that goes inside the boiler, but in that case it would be as well to get the oil through the water pipe. But you can, on the other hand, put it in through the steam pipe, and drive what is left in the injector through the check.

MR. WILLIAM FULLER—We have several hundred injectors on our line, with a self-feeding oil pipe attached. They work very satisfactorily.

MR. J. F. DEVINE—I have a question to propose: What is the best piston packing? I have tried nearly all that I have heard of, and have gone back to brass rings.

SECRETARY SETCHEL—This is quite an old subject. At one time we had a committee on this, but that was some years ago. We have now piston packing with a coil spring, and some with a coil spring with a wedge, self-adjusting. A number are using a different kind of metal than that which has been in general use. I have thought that the simple packing with a T head and the rings sprung over it was the cheapest. I believe in the West it is in general use. I believe there are packings made where an engine will be of more service, if the packing is kept properly adjusted, than with the kind spoken of.

MR. H. N. SPRAGUE—I am using a solid ring sprung into a groove, and I believe I am peculiar in my way of fitting it up. I compress the ring before I turn it. I mortise the ring so as to spring it together, and then turn it through, both inside and out, while under compression.

Then when we cut the ring off it opens out of round, but when it goes into the cylinder it is perfectly round, with a tendency to spring out. A common practice is to turn the ring larger than the cylinder, then cut out to get your compression.

THE PRESIDENT—If there are no further questions we will proceed with the report of the Committee on Construction and Improvement in Locomotives, which is the next business in order.

The report of the committee on this subject was then read by the Secretary.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee, to whom was referred the subject of Improvements of the Locomotive, would respectfully state that they have endeavored to secure information bearing on this subject from which to make a report.

We find, however, that the past year has been like the preceding two years, as years in which very little change or improvement has been made.

We may assume this arises from the fact that the business on the railroads has considerably diminished, and was not a very favorable time for experimenting. While there is still room for improvement of the locomotive, the field for the same is diminishing. We consider the locomotive of the present day well adapted for the service required. It is only by comparing the locomotive of the present with those of the past that we note the great changes that have been made. Our attention is called to this very forcibly in noting the photograph of the locomotive "Old Ironsides," the first locomotive built in the U. S., in comparison with the locomotive of the present day. (See photo.) By these we see the improvement and change made. Among the improvements noted as having been made the past year, is a boiler for locomotives, known as the "Coventry Boiler;" a blue print of same is kindly furnished by H. G. Brooks, President of Brooks' Locomotive Works, (at which works this boiler was built) and herewith presented. (See plate No. 27.) It is known as a return flue boiler, having forty-three (43) 3 inch return flues, the smoke stack being placed over the crown sheet. This boiler is built in capacity to suit standard eight (8) wheel engine cylinders

17"x24". As no trial has yet been made with this engine, your Committee can furnish no data as to its performance, etc.

Jacob Johann, General Master Mechanic of the Wabash, St. Louis & Pacific Railway Co., writes on this subject as follows:

"The general tendency among American Master Mechanics seems to be towards building larger boilers, thereby increasing the heating and water capacity, and in my opinion this movement is in the right direction, especially in the case of fast running engines that are required to handle heavy trains. The increased piston speed necessitates an increase in the capacity of the boilers, to furnish the steam required to maintain such increased speed, and no matter what other improvements or perfections a locomotive may have, if the boiler is not capable of furnishing all the steam that is required under any and all circumstances, you can safely predict a failure as being the result of neglecting one of the most vital parts of a locomotive.

"Another tendency is towards increasing the working pressure of the steam, thereby necessitating a stronger boiler, and requiring the giving of more attention to the material of the boiler and fire-box, the manner of riveting, and the strength of the bracing.

"Every advance in this direction, securing more effective work from the evaporation of a given amount of water. The great desideratum in a successful and economical engine, consists in having as large a boiler as possible, with a maximum heating surface, and so designed as to safely carry a working pressure considerably above the ordinary practice. In neither of these directions, in my opinion, has the limit been reached, and he who first reaches the limits in these three directions will be the first to secure the fastest and most powerful locomotive, under given conditions.

"As a matter of course there are minor details that must be improved in proportion, but the credit of making the greatest improvement over the American locomotive of to-day, will be due to the one who first designs a boiler that in practice will furnish an abundance of steam under every circumstance that may be brought to bear in the working of the engine; as the past history of events has proven, apparent improbabilities have become not only probabilities, but actual realities."

Mr. Alex. Mitchell, Superintendent of the Lehigh Valley R. R. Co., has furnished your Committee with blue prints of a locomotive designed by him for heavy mountain service, also photo of same. The general dimensions are as follows:

The boiler is 54 inches diameter at front end, material "Otis Steel;" fire-box 11 feet long; flues 238 in number, 2 inches outside diameter, 12 feet long. Cylinders 20x26, with 50 inch drivers, and weighs 108,000 pounds, has flange tire on the 1st, 2d and 3d, and plain tires 7 inches wide on the 4th or rear pair of drivers, and has a single wheel or pony truck front and back, having 5½ tons on the 1st and 4½ on the latter truck, the object being to get a large engine for heavy service with a short rigid wheel base.

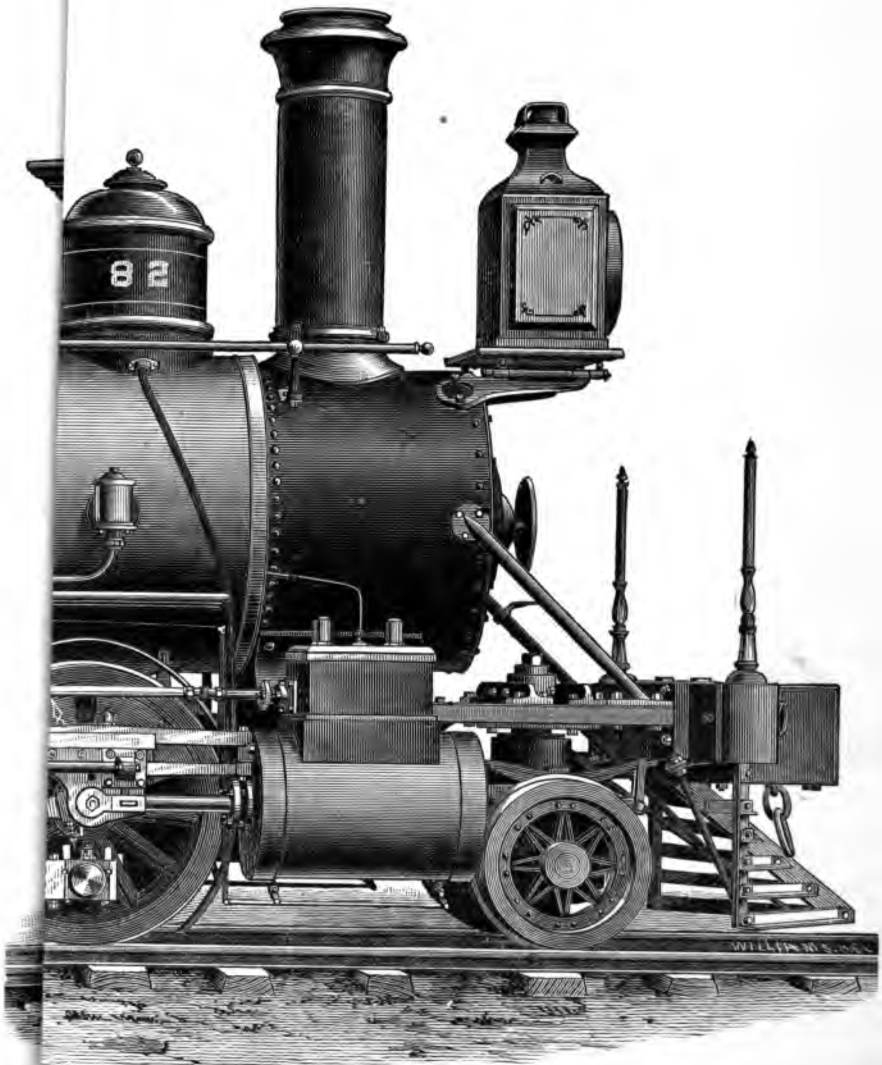
The front truck is equalized with the 1st and 2d pair of drivers. The 3d and 4th pairs are equalized, and the rear truck takes its own weight, having a deep pocket with long spiral springs on the center plate and volute springs over the boxes.

He says the engine curves and hauls very well, but cannot give data sufficiently accurate as to either, but sends you blue prints of new engines built on this plan, as shown on a curve of 330 feet radius, and you will notice that the engine with five pairs of drivers has flanges on the front, while the rear has a plain tire, and the other has plain tires both rear and front.

The Schenectady Locomotive Works furnished your Committee with blue prints of a Mogul freight locomotive with cylinder 19x24, built at their works, for burning bituminous coal.

Among the principal features of this class of locomotives is the wide fire-box, placed on top of the frame as shown in print, and is a departure from former plans of boilers, and which seems to meet with favor by our master mechanics and is rapidly coming into use.

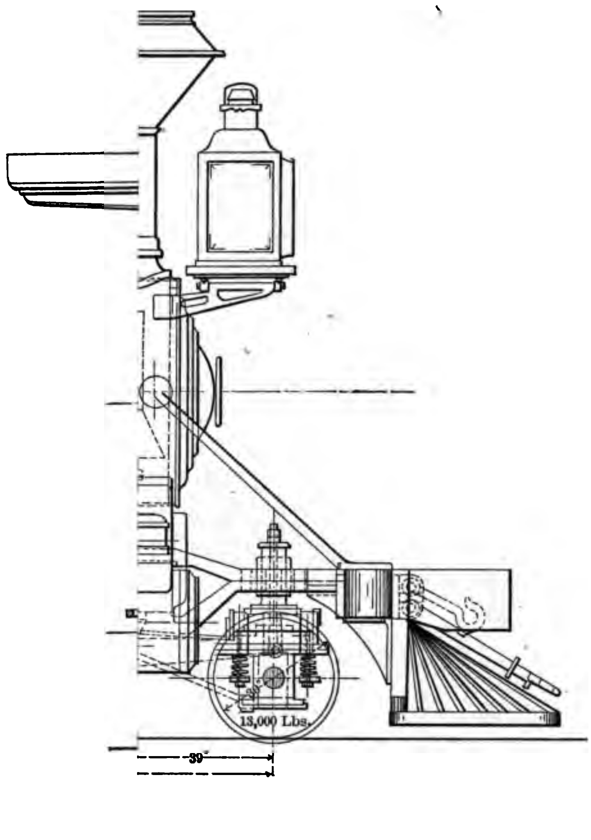
The performance of these engines is reported as very satisfactory. A complete specification of this engine is included in report and is as follows:


82

Size of main crank pin journals, ... 5x5 inches.
Size of coupling rod journals, front and back, ... 3½x3½ inches.
Size of coupling rod journals, intermediate, ... 5½x3½ inches.
Length of driving springs, measured from center to center of hangers, front, 34 in.; main, 44 in.; intermediate, 26 inches.

Boiler.

Description of boiler, ... Wagon Top.
Outside diameter of smallest boiler ring, ... 54 inches.
Material of barrel of boiler, ... steel.
Thickness of plates in barrel of boiler, ... 7–16 inch.
Kind of horizontal seams, ... treble riveted, welt strip inside.
Kind of circumferential seams, ... double riveted.
Material of tubes, ... iron.
Number of tubes, ... 212.
Diameter of tubes, outside, ... 2 inches.
Distance between centers of tubes, ... 2 11–16 inches.
Length of tubes, over tube plates, ... 11 feet.
Size of fire-box, inside, length 108 5–16 inches, width 42⅞ inches, depth from under side of crown plate to bottom of mud ring, 53 inches front and 49 inches back.
Water spaces, sides, back and front of fire-box, ... 3, 3, 4 inches.
Material of outside shell of fire-box,. . . . . steel.
Thickness of plates of outside shell of fire-box, ... 7–16 inch.
Material of inside of fire-box,. . . . . steel.
Thickness of plates in sides and back end 5–16 inch, and crown of fire-box ⅜ inch.
Material of tube plates, ... steel.
Thickness of front and back tube plates, ... ½ inch.
How is crown plate stayed, with girder or screw stays ? . . . . girder.
Diameter and height of dome, ... 30x30½ inches.
Maximum working steam pressure, ... 140 lbs.
Kind of grate, ... rocking.
Grate surface, ... 32.3 sq. feet.
Heating surface in fire-box, ... 141.3 sq. feet.
Heating surface of the outside of tubes, ... 1211.2 sq. feet.
Total heating surface, ... 1352.5 sq. feet.
Kind of blast nozzle, single or double, ... double.
Diameter of blast nozzle, ... 3¼ inches.
Smallest inside diameter of chimney, ... 18 inches.
Height from top of rails to top of chimney, ... 14 feet, 9 inches.



13,000 Lbs.
39"

To the American Railway Master Mechanics' Association:

GENTLEMEN:—Your Committee on Shop Tools and Machinery beg leave to report that we issued the following circular:

To the Members of the American Railway Master Mechanics' Association:

The undersigned, your Committee on Shop Tools and Machinery, respectfully solicit replies to the following questions:

1. To what extent are you milling work, either in fitting or finishing? Do you consider it desirable to extend the use of milling machines in locomotive work?

2. Do you use any machines other than the ordinary slide lathe for making and threading bolts, set screws or studs? If so, please describe them or give name of machine and state advantages.

3. Are you using grindstones, emery wheels or belts for finishing work? If so, please state what kinds of work and the advantages over ordinary methods.

4. Have you any special tools for cleaning, scarfing or welding tubes? If so, please give maker's name, or, if possible, send drawings and state advantages.

5. To what extent do you use dies and formers in smith shop, and with what advantages?

6. Have you any improved machinery or any special tools or devices (however simple) not in general use that improves or economizes work? If so, please give maker's name, or, if special, describe, and, if possible, send drawings and state advantages?

We trust the members will realize the necessity of furnishing full information on this important subject, that the committee may submit a useful report to the Convention.

Replies to be sent before April 1, 1884, to H. N. Sprague, of H. K. Porter & Co., Pittsburg, Pa.

H. N. SPRAGUE, of H. K. Porter & Co., }
JOHN BLACK. C., H. & D. R. R. } Committee.
J. K. TAYLOR, O. C. R. R. }

To which fourteen replies only were received from members, and some from tool builders, to whom your committee sent circulars. On Question 1st nine reported in favor of extending the use of the

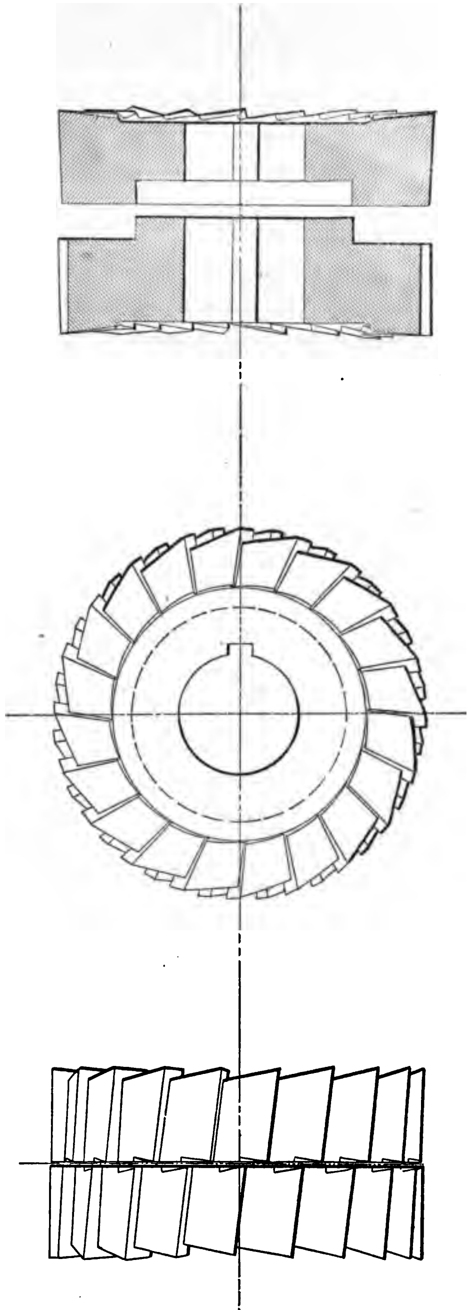


PLATE No. 37.

milling machine on locomotive work. The Brown & Sharpe Manufacturing Company say: We are constantly increasing the milling facilities in our works as being able to use cheaper help, the work in most instances being performed more quickly, and always with greater uniformity, besides leaving the parts so much smoother as to save much time in finishing. H. N. Sprague has milled all rod brasses for many years, and can do as much, or more, on one plain milling machine, as on two planers or shapers, with cheaper help, and much more accurately, saving greatly in time of fitting to strap. He submits blue print of adjustable cutter, so arranged as to compensate for wear, thereby keeping standard size of cut. Three members report in favor of using milling to a certain extent, one has no use for milling machines, and two do not report on the question.

On Question 2d—Six reported making small pins, and making and threading all studs, set screws and tap bolts on a turret head or stud machine, and all claim from three to five hundred per cent. advantage in time over the ordinary lathe, with unquestionable advantage in uniformity. Seven report only using slide lathe and bolt cutter.

On Question 3d—Eleven report using grindstones and emery wheels for roughing and finishing work to considerable extent, some doing all finishing in that way. H. N. Sprague does positively all roughing for finish, and all finishing of steel and iron forgings, brass and iron castings, and brass and copper pipe on grindstones, solid and covered emery wheels, emery belts and rollers (using solid gum rollers laid with emery, as small as one inch in diameter), and walrus leather wheels for polishing spherical surfaces, working six first-class men, in a total force of less than two hundred and fifty, and considers it the best investment the firm has, effecting a great saving in files, machinery and labor, doing all this class of work as well, and much of it better, than by the more expensive processes.

On Question 4th—Thomas B. Twombly reports using H. V. Hartz's flue machine. Has not had it in use long enough to determine its merits. We trust he will be able to report fully at the convention. James Sedgely also uses Hartz and Fise machine, doing

better work and cheaper than by hand. He submits blue print of the machine. I. S. Graham uses the same machine, with a saving of 20 per cent. Geo. Hackney also reports using this machine, with excellent results. L. C. Noble is using Charlton's hand machine for welding flues, two men welding seventy-five flues in a day. Other members report only hand welding.

Most of the members having much flue work to do report the use of cleaning barrels.

Geo. F. Morse, Portland Locomotive Works, cleans flues by slinging them in two endless chains suspended on revolving pulleys, applying sand and water, and allowing them to grind together by the motion of the chains.

W. H. Stearns uses self-feeding clamp, and three rolls for cleaning flues, but does not explain the construction of the machine farther, or the process of cleaning.

On Question 5th—Members generally report using dies and formers more or less extensively.

Allen Cook reports using Spring dies under steam hammer, saving time and help, and producing more uniform work.

H. N. Sprague uses Spring dies and formers for most shapes under hammer, also heads, all pins for valve motion and similar work under steam hammer in steel dies, counterboring for head in die, cutting off material by cutting off machine, to accurate length, saving material and considerable lathe work, as the heads are formed concentric with the body, and of uniform thickness, very little stock is required to finish.

On Question 6th—The only response is by H. N. Sprague, who submits blue print of special cutter for milling rod brasses mentioned in question first, and over head crane for general shop use, having eight of them in use in machine and erecting shops, and one in boiler shop, and thinks he could not keep house without them. On the suspended hook he hangs chain blocks or screw hoists. He prefers the latter for lifting or lowering work, the turning of the beam on its centre at opposite end, and this motion, together with the travel of the hook on the bar, allows work to be moved to any point covered by the track. Your committee confess to grievous disappointment at the ignoring of this question by the

members, and we are still convinced, notwithstanding our repeated failures, that much valuable information could be furnished by members, who doubtless all have some better way of doing some one or more things than their neighbors, and we presume the cause of its failure is fairly voiced by one member, who says in answer to it, nothing but some small tools about the shop that enables us to do work quicker, and I suppose every shop has some of their own kind "Economizes time, and yet is too simple to report for the benefit of his fellow-members," in response to a request to give anything (however simple) that improves or economizes work. Surely the age of small things must be passing away. We are glad to note an increased number of replies as compared with five received three years ago on the same subject, but submit the little interest taken, indicated by fourteen replies in a membership of nearly two hundred and fifty. Money takes more interest than that. One feature to which we are glad to bear testimony is that our progressive members are thoroughly satisfied with the advance ground they have reached, and are confident that in this direction lives success.

After carefully reviewing the subject from the best standpoint obtainable, your committee feel safe in recommending the use of a stud machine in all shops having sufficient work of a kind suitable for such a tool to keep one ordinary lathe occupied, as the saving of labor on that amount of work would much more than pay the interest on the difference in cost between the two machines, while the capacity for more and quicker work, as well as greater uniformity, are of still greater importance. We also recommend in the interest of uniformity that all bolts, studs and set screws be cut or, at least, finished in dies. The economy of roughing and polishing with grindstones, emery wheels and belts, we would recommend to your earnest consideration, and while we think the work of the milling machine can be extended to an advantage, we are aware that its best results, aside from tool work, can be reached in large shops working on duplicate parts. Finally, we believe the age of special tools and machinery has come to stay and that those who adhere to old time notions of doing work, getting one machine to do many kinds of work, doing no kind economically or accurately, will certainly get left.

The logic of the aggressive competition in mechanical advancement points unmistakably to the survival of the fittest.

Respectfully submitted,

H. N. SPRAGUE, of H. K. P. & Co.,
JOHN BLACK, C., H. & D. R. R.,
J. K. TAYLOR, O. C. R. R.
} Committee.

To the American Railway Master Mechanic's Association:

GENTLEMEN—As Chairman of Committee to furnish information as to best material for locomotive truck and tender wheels, I beg to report as follows:

Out of three hundred circulars sent out I much regret to report only thirteen replies were received, and many of these contain but little information on account of having had little or no service of steel tired wheels. Out of the total thirteen reports there is reported 1260 steel tired wheels with various kinds of centers, and 2996 cast spoke and plate wheels in use. These numbers include many different makes and patterns of wheels.

The opinions of the thirteen are: nine of them prefer steel tired wheels, three prefer the chilled cast-iron wheel, and one is undecided. One member whose preference is cast chill wheel thinks the plate wheel better than the spoke wheel on account of easier to keep clean and less liable to fan the dust up into the working parts of the engine. He has twenty-four Allen steel tired wheels in service in engine trucks, and finds the rapid abrasure of the flange is such that they need to be turned off to obtain a better flange before the tread of the wheel requires it. He thinks the cast wheel safe enough where a careful system of inspection is maintained.

One prefers a cast wheel center with steel tire called the Brunswick. With this wheel the tire can break in two or more pieces without leaving its place.

A blank form was furnished with circular with request to fill up, which would show the relative cost of cast-iron wheels and steel tired wheels, but in no case were these blanks filled in, and all who referred to it claimed they had not used steel tires long enough, or that they had not got the correct data to give such information.

From all information obtained from the replies received your Committee have been able to decide first, that although from the number reported there is largely an excess of cast chill wheels in use, the preference is for steel tired wheels. This preference is divided among several makers. But little trouble has been experienced from steel tires coming loose.

Respectfully submitted,

C. H. CORY,
R. C. BLACKALL, } *Committee.*
J. B. ROSS,

SECRETARY SETCHEL—We have had a long session this morning and I suppose the members are getting tired out. In the report of the Committee on Boilers some points were passed over without discussion, while others that the Committee was unanimous upon were heartily discussed. I know there were some points there which were passed over that not half a dozen members in this room believe in. I think that is wrong. In regard to this report on shop tools and machinery, we should have had some discussion on it; also in regard to this question of best material for locomotive truck and tender wheels. I don't believe a steel tired wheel is as safe as a chilled wheel, unless the tire is put on so that it is impossible to become loose in case of breakage. Only recently I visited a large road where they stated that they could hardly keep wheels enough turned for current use on account of the wear of the flanges, and on account of this, are regarded by many as being unsafe. It seems to me, gentlemen, if this be a fact, we ought to be able to state it. The proceedings of our meetings do not stop here. They are looked upon with interest by master mechanics, by machinists and by similar organizations the world over. If we have no views in regard to these matters, it is hardly worth while to appoint a committee upon them.

MR. J. N. LAUDER—After the castigation which we have received from our Secretary, I think it is incumbent upon us all to give expression to our opinions. I hope every man will be ready to commit himself as freely as Mr. Setchel has. I am going to commit myself in favor of the steel wheel, not for the purpose of getting up discussion, but because I believe in it. Our road has kept no records, so that I am unable to present any figures about this, and therefore I do not want to be catechised too closely. My observation, however, is that a steel wheel is economical, and we use it in preference to a chilled wheel. I allude to the so-called Washburn Alston wheel. This wheel has a cast steel

tire with a cast iron center welded through it. We have about one thousand of those wheels running under coaches, engines and engine trucks, and we have yet to find the first failure in any way. I have not been able to see any excessive flange wear on any of those wheels, if they are properly mated—that is, if they are of the same size. The wheels we have taken out for turning are from being slid by the action of the brakes, or from tread wear by actual use. Occasionally we have one with a sharp flange. In most cases the flanges wear longer than the axle. We have recently put in our shops a lathe for the purpose of turning these wheels, and we are able to turn, where they are badly worn, from three to four pair a day. The low cost of the wheel makes it, I think, a very desirable one to use. Possibly after the wheels are reduced say two inches in diameter by wear and turning, we may find defects in those tires, but we do not so far, and we have reduced some one inch in diameter half an inch on each side—and the steel is as free from defects as any railroad steel I ever saw. What our experience may be after a while, of course I can't say, but my observation with that wheel at present is entirely in its favor. Those wheels are being used largely in England, and so far as my knowledge extends they are being used there successfully.

MR. FLYNN—I am sorry that I differ with my friend Lauder. I have had a little experience with those wheels—not to the extent though that Mr. Lauder has. I put them under five engines and tenders. The great difficulty I found with them was our road being very crooked, that I had to turn them off for the purpose of getting up the flange. They became unsafe, not from any imperfections on the tread of the wheel, but from the wear on the flange. We all know that it is a very hard matter to have a perfect tread chilled wheel. The expense with the steel wheel, in my mind, is not alone 100 per cent., but greater even than that. You take the most perfect tired steel wheel, I think at from 50 to 60—I am not conversant with the 33 inch Allen wheel—but you take a good 33-inch chilled wheel and it can be bought for $10.50. If the Allen paper wheel is worth $60, you are paying about ten times the price of a chilled wheel, and when you get through with the chilled wheel it is worth half as much as you paid for it, at least one-third. So that in reality your chilled wheel has not cost you more than $7.50; that is, taking the actual cost to you as being $10.50. Parties object to buying the Allen wheel second-handed, because of the fact of the steel tire cast upon it, and in many cases where we have sold old steel wheels, I have had to deduct the weight of the Alston wheels that were in it. The reason I tried the Alston wheel was that it was so much cheaper

than any other steel tired wheel. It is at present, or was a short time ago, about double the price of the chilled wheel. Therefore it comes nearer into competition with the chilled wheel, while the imperfections that exist in it make it a more costly wheel by far than the chilled wheel. I am frank to admit that I do not think that there is any wheel in use that is as good as a perfect chilled wheel. It is a very rare occurrence to have an engine truck wheel—a good chilled wheel—break. I don't know of one in my memory. There have been some three or four tender wheels broken. We use a spoke wheel under the engine truck. In the Alston wheel several of the flanges broke off, especially one, which was worn off about one-half. The opinion I hold on this subject is, that up to the present day there has been nothing produced, when you take cheapness into consideration—which all railroads more or less do—equal to the chilled wheel. I admit that the other wheel looks nicer, but I shall always hold to the old chilled wheel as being the best for economy, and safer because when you get the flange to wearing and the metal is not smooth in its nature, when wearing against the side of the rail it is liable to mount, especially on curves. On many straight roads in the country, the experience with a steel tired wheel has proved very good, but for crooked roads I do not think it is equal to the chilled wheel.

MR. A. G. EASTMAN—I have several different kinds of steel tired wheels in use on our road, and I have in my mind approximately the amount of service from some of them, and I confess that I must side with my friend, Mr. Lauder, in regard to the flanges. I have one pair of steel tired wheels that have run under a heavy passenger locomotive three years last March, making nearly 150,000 miles. They have not been turned and they have not got a sharp flange. They do not vary over one-thirty-second of an inch in diameter on the track. It appears to me to be a matter of the quality of the tire. I have had some flanges on spoke wheels cut badly. I found the tire cut to be the smallest wheel. Some of them have been put on to the axle of different sizes. On others, the tire seemed to be firmer. I have, I think, 32 Paige wheels. I have not a case of a cut or a worn flange. I have one tire, unfortunately, that has a flat spot that I have got to take out. That is due to a defect in the steel, I think. I have two 42 inch paper wheels that have been run three years. I have just turned the tires. There is no approach to a cutting of any flange on any pair of wheels. Those cars run from Montreal to Portland, If you can find any more crooked road than that on the continent I have yet to see it. Our road is very crooked. The Portland & Ogdensburg R. R. is

also very crooked. And I think if the trouble was with the steel tires, we should have got some sharp flanges on those wheels. If they cut flanges, it is because of some defect in the steel, or from an unequal diameter of the tire.

MR. J. N. LAUDER--We must approach this question with fairness and not with prejudice. For engine trucks I have had the difficulty that Mr. Flynn speaks of in the matter of cutting flanges. A road that I was connected with several years ago had one very crooked division. I found it impracticable to use steel tired wheels for engine truck wheels, on account of their tendency to cut the flanges. I would run a tire forward until they got sharp, then turn the truck around and run it the other way a while. I then turned them. But for car wheels where they are not thrust against the curves so sharply, I don't think there is any trouble in running any kind of a tire. I know there is some difficulty on some roads. On the California Southern R. R. I have seen engines that had run there one year with the wheels, when taken off, of no practical value; they had to be thrown away because their flanges were sharp.

MR. J. D. BARNETT—I would like to ask Mr. Lauder whether his cast steel tire was cast on to the center, or the center on to the tire?

MR. J. N. LAUDER—Perhaps a little explanation of the mode of manufacture would be interesting. In one end of the shop is a steel furnace for making crucible steel. At the other end is a cast iron cupola of the ordinary depth. In the center is the arrangement of flasks. It takes two casts and two operations to make a wheel. First, they take the crucibles out and get enough metals in there to make a tire. It is then lifted out of the crane and swung around and put in another flask, and the cast iron pored inside of it. That is all there is of making a wheel. I have seen hundreds of them broken up with a view of seeing whether the union of the two metals was united, and the union was always as near perfect as possible. I had always been a cast iron wheel man until I got hold of these wheels.

MR. W. B. WARREN—I have nine locomotives fitted with the Allen paper wheel, and my experience is that there are no more sharp flanges in proportion than on the cast iron running on the same roads. I was once a cast iron wheel man, but for the last two years I have somewhat changed. I am not satisfied that it costs any more to run the paper wheel, but there is but little difference, so far as I have tested them in the last two years, in my opinion. We have some sharp flanges in the steel wheels. I found a little difference in turning up of some of them. I think it partly in the material. They ran, say from eighty to a hun-

dred thousand miles, without turning. I think the steel and cast tire will give us a pretty fair illustration of the two metals, cast iron and steel.

MR. A. G. EASTMAN—I wish to correct one statement that I made, and that was in regard to those paper wheels. I said they ran three years. I should have said three seasons. We only used them during the summer months, probably equal to fourteen months continual wear.

On motion of Mr. Sprague, the Convention then adjourned to nine o'clock Thursday morning, June 19th.

THIRD DAY'S PROCEEDINGS.

The Convention was called to order by the President at 9.20 P. M.

THE PRESIDENT—When we adjourned yesterday the subject of the best material for locomotive truck and tender wheels, was under discussion. That subject is now before you and we will hear any remarks that members have to offer.

MR. H. N. SPRAGUE—If we are to continue the consideration of this subject I should like to have some member conversant with the position of the question at the close of the proceedings yesterday make such statement of the facts as will enable members who were not present to understand it. We are rather short of time, and what is said should be said promptly and to the point.

THE PRESIDENT—If there is no one wishes to make any remarks on the subject, we will pass on to the next. The next subject in order is, "The best practical method of educating engineers." There is a report of a committee on this subject. The committee consists of John H. Flynn, J. N. Lauder, and C. K. Domville. I believe the Secretary has the report.

SECRETARY SETCHEL—The members will find printed copies of the report scattered throughout the room.

The Secretary read the report as follows:

REPORT OF COMMITTEE ON "BEST MODE AND MANNER OF EDUCATING YOUNG MEN FOR LOCOMOTIVE ENGINEERS.

To the American Railway Master Mechanic's Association:

GENTLEMEN—Your committee, appointed at the last annual convention to report at this meeting on the subject of the "best mode

and manner of educating young men for Locomotive Engineers," beg to offer the following report:

Considering this subject to be of vital importance to the Association and to the public in general, and that proper care and attention have not been given to it in the past, the committee have spared no pains to get all the information they possibly could on this subject, knowing and feeling that men selected to fill the responsible position of locomotive engineers must possess faculties that, as a general thing, do not belong to all the human race; and as locomotive engineers have to be selected from the ranks of firemen, they feel that due care and caution should be exercised in selecting young men for firemen. Now, to arrive at a proper conclusion—one that would be satisfactory to the Association, and to the railways of the country, your committee sent circulars to all the Master Mechanics in the United States, Canada and Mexico. We sent out five hundred and thirty-two (532) circulars, to which we received seventy-six replies, being on an average of one answer to every seven sent. Many of these replies contain very valuable information, and were from many of the leading roads of this country, Canada and Mexico. Your committee beg leave to return thanks for the answers to their circular.

The opinions given us by the different Master Mechanics who replied were as follows: Five recommended that none but machinists should be locomotive engineers; nineteen thought nothing more was needed than to have a young man fire from three to four years with good competent engineers to make him a good runner; fifty-two thought that one year in the shop and round-house, with two or three years' firing, was necessary to make a competent engineer; many recommended that young men, while firing, read and study books that would give them a general knowledge of the locomotive, such as "Forney's Catechism of the Locomotive," and several other works of that kind. Many of the replies admitted that machinists would make the best runners if they would consent to fire one year after having learned their trade, as they would then have the advantage of knowing all about the construction of the locomotive. Of course, when speaking of that class of men, they meant bright, intelligent young machinists—men with nerve and

energy, and quick to act in cases of emergency. Of course, there are some who would never make engineers, no matter what opportunities were given them. If young men of this kind would consent to run one year or more as firemen, we could select our locomotive engineers from among that class; but they will not do it, from the belief that they are just as competent to run a locomotive as the best engineer on the road for which they are working, and if they are given an opportunity to run an engine they are certain to make a failure.

This being the fact, we are compelled to select our engineers from among the ranks of the firemen, as the best and safest runners. Now, this being the class of men from which we have to select our engineers, some uniform mode of instructing them for the responsible position that many of them will have to fill in the future will have to be adopted by the different railroads in America. Your committee would therefore recommend the following:

All Master Mechanics should have full control of the engineers and firemen in the employ of their respective roads, with full power to hire and discharge the same—of course, recognizing the rights that the General Managers or Superintendents have to order the discharge of any engineer or fireman for neglect of duty.

1st. The qualifications for the position of fireman on all the railways in America should be as follows: The applicant should be from eighteen to twenty-four years old, able-bodied and in good health, with a good common school education and a fair knowledge of arithmetic, and of sober and steady habits. All applicants should be required to make application in their own handwriting, signing it in the presence of the Master Mechanic or the person he may appoint to hire that class of men. In selecting men for firemen, great care should be exercised. The Master Mechanic should endeavor, so far as lies in his power, to select energetic, smart and active young men—men of nerve and presence of mind, quick to act in cases of emergency which may occur in the position they may be selected to fill in the future. If we select men of that kind there will be very little difficulty in educating them up to the proper standard to fill the place of engineers.

2d. There should be three grades of firemen, classed as Junior,

Intermediate, and Senior Firemen—the young man just commencing to be classed as Junior Fireman, and so on up to Senior Fireman; the Senior Fireman receiving the highest pay for his services, the others in proportion. When a fireman has fired four years and is worthy of promotion and fully competent to run a locomotive, there may be no vacancies in the engineer force on the road by which he may be employed. In that case we recommend that he receive a small amount more per day than the Senior Fireman (say from fifteen to twenty cents per day more), and ranked as Veteran Fireman. On the road which one of your committee represents in this Convention this custom has been in vogue for a number of years, and has worked exceedingly well. All the engineers on this road have been educated under this rule, and to-day no engineers in the country rank higher than they do.

Proper care should be taken in selecting young men for firemen as to their ability to distinguish colors in a practicable, common sense way. We recommend that all railroads having a sufficient number of employees to justify them in so doing, have a reading-room and library for their firemen and engineers, in which the other employees could participate. The library, to some extent, should consist of works on the locomotive engine that a man with fair education could understand. While we do not think it essentially necessary, still we believe it would be beneficial to some extent to let firemen work one year out of the four in the shop and roundhouse, so that they might obtain a more perfect knowledge of all the parts of the locomotive.

Young men consisting of the class we have mentioned are certain to make good runners, and there will be no difficulty, at the proper time, to select good junior engineers from that class of men. All opportunities possible should be given firemen to get such knowledge of the theory and movements of the different parts of the locomotive as would be beneficial to them when they enter on their career as engineers. To accomplish this end, monthly lectures might be given in the reading room by men of good practical common sense, who fully understand what they are talking about. If possible, these lectures should be given by one of the engineers. The firemen would learn more from him, as they would

better understand what he was saying, he having formerly been one of them.

Your committee is convinced that if the mode recommended by them is adopted generally throughout the country that, if not all, a large majority of the firemen would be educated to a point from which there would be no difficulty in selecting men who will make good and reliable engineers.

3d. The fireman now being competent to run a locomotive, and being placed in charge of one, has yet some few things to learn that he did not have the opportunity of learning, from the fact that he was not running the engine. While he may run carefully and avoid accidents, he has to learn to run his engine with economy in the consumption of fuel and the cost of repairs. To learn this and to give the young engineer an opportunity to become a first-class man in his occupation, we recommend there be three grades of engineers—first, second and third grades—and that the remuneration they receive be according to grade; the fireman just promoted ranking in the third grade; after one year's service he enters the second grade; when two years have passed he enters the first grade and becomes a first-class locomotive engineer.

Your committee is confident that if the different railways in the country will pursue the mode and manner laid down in this report, there will be no further difficulty in selecting good and faithful men to fill the responsible position of engineer. They recommend the adoption of this report.

Respectfully submitted,

JOHN H. FLYNN, Chairman.
J. N. LAUDER,
C. K. DOMVILLE,
Committee.

THE PRESIDENT—Gentlemen, you have heard the report of the committee read by the Secretary. How will you dispose of it?

MR. H. N. SPRAGUE—I move that it be received.

MR. JOHANN—Second it.

Motion carried.

THE PRESIDENT—The report is now before you for discussion.

Mr. H. N. SPRAGUE—I approve of the report, as far as my judgment goes, with one exception. I should be glad to see our firemen instructed

as much as possible. I think the idea that it is not absolutely necessary that they should spend a year in the shop is a mistake. I think it is necessary for an efficient engineer. There are many positions where we expect an engineer to do running repairs; and in any event it is very important that an engineer should know something of the internal arrangement of an engine, which it is difficult to learn on the road. He never takes the engine apart on the road, and how is he going to know about its construction. I think it is highly essential that a fireman should spend a year in the shop before being promoted.

MR. J. H. FLYNN—I will admit that for some sections of the country that may be necessary. The committee recommended particularly smart young men. When you placed that class of men as firemen you place men that are continually thinking and expecting to be promoted. Their whole attention is devoted to the occupation which they are filling. On the road of which I have been master mechanic for 27 years, this has been our policy, and to-day in our section the engineers of our company rank as high and much higher than a great many roads. It is to a certain extent the standard for roads in that section. That class of young men should run our fast trains and best engines. If they break down on the line they can get their engines in if it is possible to do so. My remark was that it might be essentially necessary in one section of the country, and by that I mean just to say in the Southern States to some extent. We think engineers should only do ordinary repairs, such as packing the stuffing boxes and other little things they can do. We do not expect them to meddle with the valves. We do not allow that. The fireman learns from seeing him do his work, and it is a very rare thing that a fireman firing three or four years on a railroad would not have had the experience sufficient to put an engine in condition to move it to the siding or to bring it into the shop.

If we select an ordinary class of men, instead of as suggested by the report, we see the great necessity for a young man to go into a shop. Such a man as that it would be beneficial to. He goes into the shop, helps to jack up an engine, helps to do a certain amount of the work there or in the round-house, and all that is beneficial to him, because he sees there the way the machinery is put together. But the meaning of that report is that if we should select any man that is dull to comprehend at all we make a mistake, and we should be quick to remedy it by dispensing with his services.

But if you carefully use all the knowledge you can in the selection of young men, and you start right, there is no necessity for their going into a shop or round-house, because they learn to manage a train with econ-

omy, to take down the machine, and to put it on one side when she breaks down, and other work necessary to get it into the shop. I want to explain one remark there in regard to machinists. We all know that if we take a machinist and put him on an engine he goes on with a superhuman confidence that he knows as much about running an engine as the best engineer on the road. There is no doubt of it I went out on the Madison and Indianapolis Railroad in Indiana where I did my first running. The master mechanic, who is still living, finally told me: "I will not give you an engine to run on this road unless you fire." I thought that was piling it on too thick, and that I was as good as any engineer, and could handle an engine just as well. I went out to fire. Now, to show you how young machinists act with their firing, we were running between Danville and Columbia, and I thought the engine was not run exactly as it should be, and it was my impression inwardly and foolishly that I knew how to do it. So I made the remark to the engineer: "Here, you ought to run this engine this way." He just turned around and he took me by the shoulder and said: "Young man, you're on this engine to fire. I don't want any suggestion from you about running." Naturally, I felt very much cut, and I spoke to him no more until we got to Indianapolis. He let me do my part of the work, and he attended to his. When we got into Indianapolis he saw I felt rather hurt, and he said: "John, I have done this for your own good. You have got too high an opinion of your ability to run a locomotive." I believe it did me good, and I never forgot the lesson. We have a few machinists on our road, and I endeavor, when starting them out, to inculcate in them the fact that, whatever they can do in the shop, they know virtually nothing about running a locomotive; they know nothing about handling a loaded train, about running regularly between stations, up and down grade; and unless there are some lessons given them through firing, they always make a failure, and in a short time are taken off. I don't mean to say that there are no machinists who will make good engine runners, but I do say that in order to do it they must go out on the line and fire, where they learn the management of trains; learn how to stop, and in what distance they can stop in, and the many other things incidental to running an engine on the road. This is what the machinists need, if they would only do it. We could then select our engineers from our machinists; but the trouble is they have too much confidence in their own abilities. In concluding my remarks: If the course pursued in the selection of young men is as laid down in that report, we shall have no difficulty.

MR. SETCHEL—I will admit that it would be a great convenience,

and advance the present standard of firemen, but, in my experience, where we have 40 to 50 young men together in different branches, we must pick out the bright young men. When we find that we had one of the other kind—an ordinary young man—we don't feel like turning him out. I think the next move would be to ask a year in the shop.

MR. J. N. LAUDER—The remarks made by Mr. Sprague got me on my feet. In my opinion there is not a young man in America but wants to fire a locomotive, and that being so, we certainly can have our choice. There is nothing more frequent to master mechanics than applications for positions as firemen. That being the case, we can select the brightest young men in the country for firemen, and it is our own fault if we do not do it. If we find we have got a boy that will never make a runner, we are not obliged to promote him, even if we were obliged to keep him firing. We are not obliged to promote a man unless he shows capacity to make a good runner. I believe with Mr. Flynn in what he has said about the undesirability of having machinists for runners. I have seen very few machinists who ever made good runners—not because they were machinists, but because they had never learned their trade as runners. A man can not be a good workman without learning his trade. Learning the machinist's trade is not learning the art of locomotive running. A man has to go on a locomotive and fire, and it takes years to do it. I should be loth to put a fireman running unless he had fired from three to four years. I think the best system is to pick yearly as many firemen as will have to be promoted as engineers and put them into the shop, and then they would understand that the putting of them into the shop is promotion, and that if they served well in the shop they will get engines to run. Their shop experience will be worth a great deal to them, and when they go out they will be fit for locomotive runners, though they may not be practical machinists. My trouble is to get engineers to let engines alone. Let the engineer run his engine, we will do the repairs; we keep a shop and men trained for that purpose.

MR. JACOB JOHANN—I can not quite agree with Mr. Lauder in his ideas. I think a locomotive engineer should not only know how to run his engine, but be fully competent to do any part of the running repairs about his engine. If we ever arrive at that stage of perfection, I think we shall be very near the millenium. I am well aware that the present system is very imperfect, and that it will require a great deal of time to get it in a more satisfactory state. The roads in these Eastern states that are limited to about 300 miles, I see no reason why the master mechanic should not get his engineers under pretty fair discipline. One of the

troubles with our Western roads has been that we have built railroads faster than we could educate the engineers, and consequently we have put up with a great deal of indifferent engineering. We will have to improve the character of the engineer, and I have no doubt we may possibly live to see that service more perfect than it is now. In the manner of educating engineers, as a matter of course, they have got to commence as firemen. I have not any very perfect system of trying to arrive at that result; but we now take boys of about eighteen years of age, and insist on their going into the round-house first as wipers and floor sweepers, or anything of the kind to make them useful in some general way, and assist around the engine house, by which they will get some general knowledge as to the operation and manipulation of engines. After they have worked there for six months or so, and if they are pretty apt, industrious boys, we take them into the machine shop, not as apprentices for machinists, but we take them in there as general helpers, and make them work around the pits, to take down and put up the engines, and help the men generally, so as to get familiar with all the parts of the engine; and we keep them there from six months to a year, and, if they develop satisfactorily, we then send them to fire. After we have sent them firing, it depends then entirely on their own exertions whether they are ever promoted to be engineers or not. Some are and some are not, and when we discover that some man is not going to develop into an engineer we generally set him one side, and do not allow him to continue on an engine. I think that is the proper way to proceed, and that is my present practice. It may not be the best way possible; but I am still feeling my way to a more perfect system; but in proceeding in this way we find that we get a fair average engineer. I do, however, believe that an engineer should be competent not only to run his engine, but also to take down and put up, and repair, if necessary, any part of his engine; and I think in that direction we ought to look to the educating of our engineers.

MR. SETCHEL—I don't advocate making machinists of them. But how often it is that we have a special case where we expect a man to take care of his engine. If he has not had eight or ten years' experience running, he is not generally a good enough machinist to be able to take down rods, steam pipes, set out packing, and such things as that, in case he is required to do it. This experience in the shop would accomplish that. There the committee provide a system by which firemen become thoroughly competent to run an engine. But in the matter of repairs, in which knowledge is important, that depends on the amount which they may pick up during three to four years' experience as firemen. One man would probably get five times as much as another.

MR. JACOB JOHANN—One step further. Very frequently I find engineers coming in and applying for situations in my service. At certain seasons of the year we cannot furnish enough engineers. A young man will come along and we will ask him what has been his experience; "Have been running on so and so for two years." "Well," says I, "young man, I don't think your experience is sufficient to run on this road. You may be the first engineer in America, but I would not like to send you out on an engine. I have no objection to giving you employment, but you will have to fire for some time, until I can see what your capacity is, as it will depend entirely on what you can do. I will give you an engine if you are competent to take it." As a rule, they generally object to commencing as a fireman. They feel themselves above going back to fire, and they are generally men who don't pan out well. Some of them will say, "All right, I am perfectly willing." That is generally the man who will make a success. Put him to firing, and he will fire two or three months, then give him an engine and he turns out a good engineer.

MR. SETCHEL—This is a very interesting subject to me, and I have had some pretty severe experience in educating engineers. We had to educate men to fill all the positions on the road about eleven years ago, and since that time I have made it a considerable of a study—the best way to get the most competent and serviceable men for the position of locomotive engineer.

In 1873 you all remember the engineers on the Pan Handle line struck, every man, eighty engineers and firemen on the Little Miami R. R. left their engines. We were called on to supply their places, and from that time I made up my mind that I would endeavor to raise up a set of men in our own family, as it were, for locomotive engineers, men whose interests would be identified with the road, and for nine years afterwards, after the places of these men were supplied, we did not hire an engineer from a foreign road, but raised them on the road, and our plan was substantially the same as that reported by the Committee, excepting this: when we made up our mind that a man on our road was competent to be promoted we took him off from the road and put him into the round-house or the machine shop, and we made it the duty of every engineer to set out his own packing, set up his wedges, and do the current repairs on his own engine, and it is impossible for a man to do that unless he has something more than that knowledge which he has obtained from firing with some very indifferent engineers. That system worked very well, and the men understood so thoroughly that no foreign men would be employed at all, so long as we had material of our own

ready to fill the position that, as Brother Lauder says, it almost got to be a nuisance, the number of applications we received. Why, every lawyer, doctor, merchant, minister and farmer's son wanted to be a fireman. I don't wonder that Mr. Lauder thinks every mother's son in America wants to be a fireman. I have thought so myself that all wanted to fire, and on our particular road. Well, it brought us a crop of men that in four or five years every man in the employ of the Little Miami Road could have left his engine and we could have made out a duplicate telegram to each fireman to take and run his engine, and every one, without exception, would have been competent, so steady and sober were the men. Now, I think it is possible for every road to be just in this position. The engineers see that and ask, "How are we going to get employment when we get out of a job?" Now, I have thought of that question also, and I want to be just to the engineers. I think you will find that in nine times out of ten the engineer who gets out of a position, and whom his company will not reinstate under any circumstances, is not a profitable man to employ. You have a good engineer, and if he has demonstrated that he is a good man for the company and he makes a mistake I have yet to see the set of officers who are not willing when the proper time arrives to overlook the man's fault and reinstate him; so that there is no necessity for good engineers to be running about the country at all. I look with suspicion upon every man who is traveling about the country out of a job. These sort of men sometimes attempt to recommend themselves by telling of the many dozen railroads they have run on. I don't want such men. A man comes to me and tells me: "I worked on such and such a road." I say: "Why did you quit?" "Well, I thought the old man did not use me right;" and I say to myself right away that before long he would be thinking that this old man "don't use him right." So I don't hire him. In 1878 so perfect had this system become with us that out of eighty-four (I think it was) engineers and firemen we never had a single change in all the year. There was not a single man suspended, there was not a man discharged among the men employed in all that time, and that was the record I had to give to the superintendent. I think such a report as that is a great recommendation of this system that has been reported by the Committee. Now, in regard to getting bright young men, I think, as Mr. Lauder has said, that we can have our choice. We should not put a man on as fireman without a view of some time making an engineer of him, if he is not a good and reliable man. The country is too large and there are too many kinds of business in which a man can earn a living where he will not endanger the traveling public; and I say it is

our duty as locomotive superintendents and master mechanics to reject applications that we think will not fill the place worthily. Another very important point, and one to which too little attention is paid, in an examination for promotion: "I won't say I don't take a drink," says the applicant frequently, in answer to the question "are you a temperate man?" "I take a drink when I feel like it; I take a glass of beer." Well, I have sometimes said to him, "Young man, how long is it since you have been intoxicated, or were you ever intoxicated?" and he has said "it is about two months," or a very short time, but that he had sworn off. I say to him: "You must not expect to be promoted on this road unless you can establish at least as long a record for sobriety as I require you to establish as a fireman." I think that course should be adopted by us all. All the damage that is done by men when they combine together is done through the influence of drink—nine-tenths of it. If we get sober men, they are not going to do anything that is wrong to the company that employs them or to the traveling public. They are good, thinking, earnest men, good engineers and good citizens, and they are not going to throw away their positions for the chance of getting five or ten cents a day. They are men who are willing to talk the matter over, to reason, and you can do something with them. I have always said that the less men know of whisky, the better firemen or engineers they make. We can't be too careful on that point. [On motion debate on this subject was closed.]

MR. JACOB JOHANN—I would suggest in reference to the other reports they should be taken as read and printed. Unless something of that kind is done we shall not get through to-day.

MR. H. N. SPRAGUE—I would like to make a remark in regard to a suggestion from one of the members. Several of the leading members with whom I have talked think that an idea like this would be a good thing; we have got to have some statistics.

THE PRESIDENT—Your remarks are out of order. There is no question before the meeting.

MR. H. N. SPRAGUE—Mr. Johann was suggesting the old plan of stimulating business, and I thought it would be a good time to make a remark on the subject. There is something I wanted to say and if you will put me right and tell me when the proper time is, I will defer to that.

THE PRESIDENT—I think we had better get through with the business set down on our calender first, and then it would be in order to make these remarks in reference to other matters. The next business before the Convention is the report of the Committee on Balanced Side Valves: James Meehan, Amos Watts and T. L. Chapman, Committee.

The Secretary read the report as follows:

To the President and Members of the American Railway Master Mechanics' Association:

GENTLEMEN—As Chairman of the Committee selected by your honorable body to prepare reports on valve motion, I respectfully submit the subjoined report, as the result of my observations, and I regret that various circumstances have prevented me from dealing more exhaustively with a subject of so much importance.

Within the past five years the subject of valve motion and gearing has been agitated to a greater extent than perhaps ever before. This has grown out of the demand for higher speed, the aim apparently being not only to furnish a greater supply of steam, but to use the steam more economically by improved valve gearing. The result is that a substitute for or improvement on the ordinary shifting link motion has yet to be found.

While the link motion device may not be a correct one for the distribution of steam, yet when an average is struck between its simplicity, durability and efficiency, and various other suggested devices, the result is in favor of the link motion.

Many of the so-called faults of the link motion are the salvation of the locomotive. Early compression is often cited as an irremediable failing, and it is a fact that a loss of power results therefrom. It has also been found in high speed stationary engines, where the clearances are reduced to a minimum and compression commences late in the stroke, that the sudden arrest of the reciprocating parts in so small a distance, by the compressed steam, acts like a sledge-hammer blow, and has resulted in many instances in the practical destruction of the engine; but, on the other hand, the early compression of the link motion gives a soft and gradual cushion for the arrest of the piston, etc., an advantage for which may be claimed in the remarkable performance of an engine on a rough track.

It may be possible that there are other forms of valve gear more productive of economy than the link, but until such superior economy can be obtained with the same simplicity of means and inexpensiveness of operation, in my judgment, this will be the only valve gear used. The defect of wire-drawing has long been admitted on the part of the link motion, but long ports, and the use

of the Allen valve, to a great extent, have done away with this objection.

In connection with the foregoing, I would now draw your attention to sheets No. 1 and 2, containing diagrams taken from the left side of engine No. 81.

Plate 38 of diagrams were taken from the engine when quite new, or after having made but one or two trips, and I would particularly draw your attention to the close approximation of the pressure there indicated, to the line of boiler pressure, and also the line of back pressure to the atmospheric line. These were taken at a speed ranging from 126 to 276 revolutions, at different cut offs with light throttle openings, but with a boiler pressure varying but slightly.

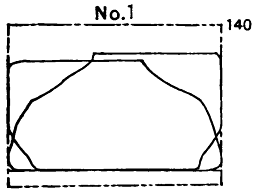
From these diagrams I think the proof is clear that with a properly arranged motion, well proportioned, back pressure can be reduced to a minimum.

Diagram No. 1 was taken after the first 100 revolutions, after leaving the starting point, cylinders being not quite hot, consequently the loss of pressure, the loss of pressure in the front end being due to the cylinder casing being removed, and a cold head wind striking directly on the cover. The main dimensions of the engine are given at the foot of the diagram, together with the general condition and load.

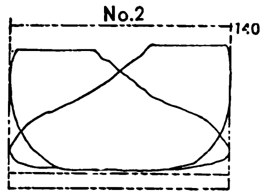
Taking the general result of these diagrams, it seems clear to me that the link motion is not responsible for back pressure, as has been largely believed, but that this back pressure results from contracted nozzles in use with the old style diamond smoke stack, and with the extended smoke arch, which allows larger nozzles and a freer exhaust, it is possible to reduce the back pressure to almost nothing, as shown by the card.

Plate No. 39 shows diagrams taken from the same engine, 81, after a mileage of over 25,000 miles.

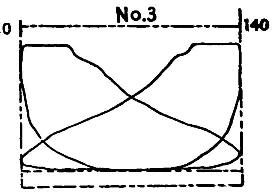
You will observe by examination that there is very little difference between the cards on this sheet and those on Plate 38; but in reference to the general condition you will see that the train in this instance consisted of two extra coaches, one being a "Pullman Sleeper," and the other being a "Mann Boudoir Car," giving an approximate weight to the train of 240 tons.



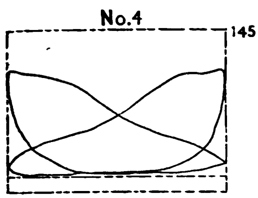
Boiler pressure 140 lbs. to sq. inch.
Speed slow.
Taken at starting of train.



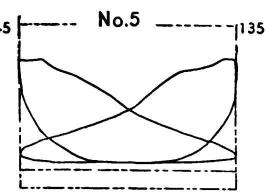
Boiler pressure 140 lbs. to sq. inch.
Cut off at 10 in.
Revolutions per minute, 126.
Throttle half open.



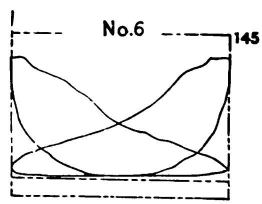
Boiler pressure 140 lbs. to sq. inch.
Cut off at 8 in.
Revolutions per minute, 144.
Throttle half open.



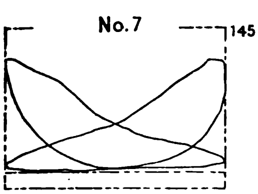
Boiler pressure 145 lbs. to sq. inch.
Cut off at 10 in.
Revolutions per minute, 150.
Throttle open one-fourth.



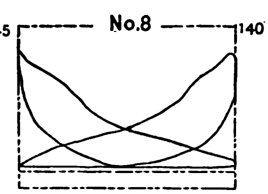
Boiler pressure 135 lbs. to sq. inch.
Cut off at 8 in.
Revolutions per minute, 180.
Throttle open one-half.



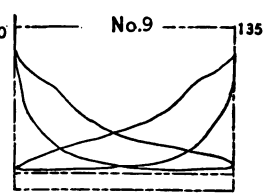
Boiler pressure 145 lbs. to sq. inch.
Cut off at 8 in.
Revolutions per minute, 222.
Throttle open one-third.



Boiler pressure 145 lbs. to sq. inch.
Cut off at 8 in.
Revolutions per minute, 264.
Throttle open one-third.

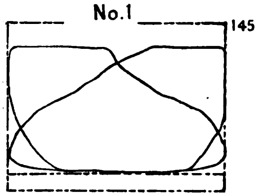


Boiler pressure 140 lbs. to sq. inch.
Cut off at 6 in.
Revolutions per minute, 270.
Throttle open one-third.

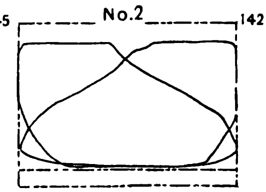


Boiler pressure 135 lbs. to sq. inch.
Cut off at 4 in.
Revolutions per minute, 276.
Throttle open one-fourth.
Speed 58 miles per hour.

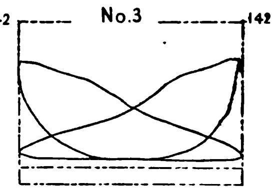
PLATE No. 38.



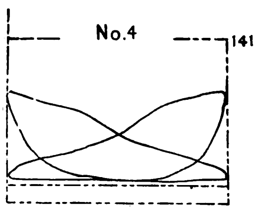
Boiler pressure, 145 lbs. to square inch.
Cut off at 14 inches.
Throttle open three-fourths.
Revolutions per minute, 130.
Grade 1.000 in. 100 feet.
Indicator, Tabor.



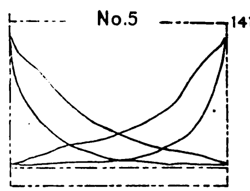
Boiler pressure, 142 lbs. to square inch.
Cut off at 14 inches.
Throttle open three-fourths.
Revolutions per minut , 120.
Grade 1.000 in. 100 feet.
Indicator, Tabor.



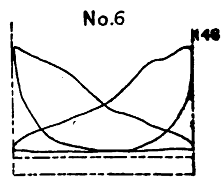
Boiler pressure, 142 lbs. to square square inch
Cut off at 10 inches.
Throttle open one-half.
Revolutions per minute, 278.
Grade 0.087 in. 100 feet.
Indicator, Tabor.



Boiler pressure, 141 lbs. to square inch.
Cut off at 11 inches.
Throttle open one-half.
Revolutions per minute, 232.
Grade 1.000 in. 100 feet.
Indicator, Tabor.



Boiler pressure, 141 lbs. to square inch.
Cut off at 4 inches.
Throttle open one-half.
Revolutions per minute, 298.
Grade, level.
Indicator, Tabor.



Boiler pressure, 148 lbs. to square inch.
Cut off at 10 inches.
Throttle open one-half.
Revolutions per minute, 240.
Grade, level.
Indicator, Crosby.

CLASS OF ENGINE—EXPRESS PASSENGER.

MAIN DIMENSIONS OF ENGINE.

Diameter of cylinder,	18 in.	Stroke,	24 in.
Number of drivers,	4.	Diameter of drivers,	68 in.
Weight in working order,	90,000 lbs.	Weight on drivers,	60,000 lbs.
Valve Gear Shifting Link.		Type of Valve—Allen Richardson.	
Outside lap,	⅞ in.	Le d in full gear,	1-64 in.
Length of ports,	16 in.	Width of steam ports,	1¼ in.
Length of exhaust,	16 in.	Width of exhaust ports,	2½ in.
Diameter of exhaust nozzles,	3¼ in.	Total wheel base,	270 in.
Rigid wheel base,	102 in.	Heating surface fire-box, 133 feet 2 square in.	
Grate surface,	17 square feet.	Total heating surface,	1457 feet 8 square in.
Heating surface flues,	1324 feet, 6 square in.		

GENERAL CONDITIONS.

LOAD—Train composed of 1 mail and express, 1 first and 1 second class coach, 1 baggage car, 1 parlor car, 2 sleepers, and 1 Mann boudoir car. Total, 8 coaches. Approximate weight 240 tons of 2,000 lbs.

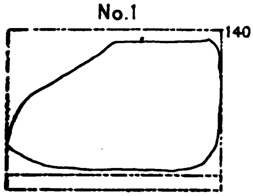
Diagrams taken with engine on regular passenger run with train as above, and under ordinary conditions, throttle openings light.

Maximum grade, 60 feet per mile. Average grade, 40 feet per mile.

Vertical scale of diagram, 60 lbs. per inch.

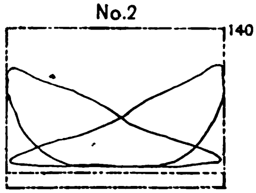
PLATE No. 39.

No.1



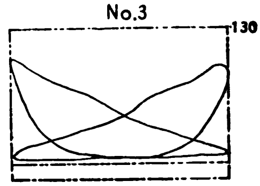
Boiler pressure 140 lbs. to sq. inch.
Cut off at 15 in.
Throttle open seven-eighths.
Revolutions per minute, 85.
Grade.

No.2



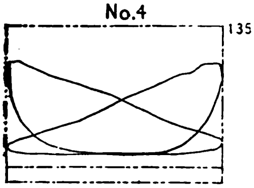
Boiler pressure 140 lbs. to sq. inch.
Cut off at 10 in.
Throttle open one-eighth.
Revolutions per minute, 132.
Grade 0.500 in 100 feet.

No.3



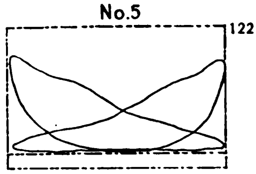
Boiler pressure 130 lbs. to sq. inch.
Cut off at 10 in.
Throttle open one-eighth.
Revolutions per minute, 198.
Grade 0.500 in 100 feet.

No.4



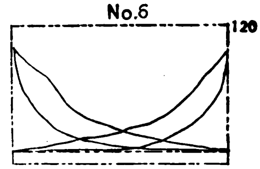
Boiler pressure 135 lbs. to sq. inch.
Cut off at 13 in.
Throttle half open.
Revolutions per minute, 200.
Grade level curve 2°.

No.5



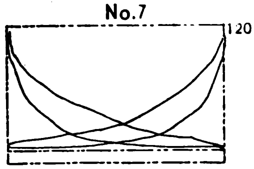
Boiler pressure 122 lbs. to sq. inch.
Cut off at 10 in.
Throttle open one-fourth.
Revolutions per minute, 144.
Grade 0.500 in 100 feet.

No.6



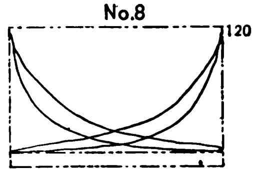
Boiler pressure 120 lbs. to sq. inch.
Cut off at 4 in.
Throttle open one-third.
Revolutions per minute, 88.
Grade 0.350 in 100 feet.

No.7



Boiler pressure 120 lbs. to sq. inch.
Cut off at 7 in.
Throttle open one-half.
Revolutions per minute, 240.
Grade 0.500 in 100 feet.

No.8



Boiler pressure 120 lbs. to sq. inch.
Cut off at 4 in.
Throttle half open.
Revolutions per minute, 208.
Grade level, 2° curve.

CLASS OF ENGINE—HEAVY FREIGHT.

MAIN DIMENSIONS OF ENGINE.

Diameter of cylinder	20 in.	Stroke	24 in.
Number of drivers	8.	Diameter of drivers	49 in.
Total weight	102,000 lbs.	Weight on drivers	80,000 lbs.
Valve Gear Shifting Link.		Type of Valve—Plain "D" Slide, with "Margach" Balance.	
Outside lap	¾ in.	Width of steam ports	1¼ in.
Length of steam ports	16 in.	Width of exhaust ports	2½ in.
Length of exhaust ports	16 in.	Travel of valve	5¼ in.
Diameter of exhaust nozzles	3¼ in.	Total wheel base	258 in.
Rigid wheel base	168 in.	Fire-box	103¾ x 42¾ wide.
Grate surface	30.7 sq. feet.	Fire-box	49¼ in. deep at front.
Heating surface, flues	1,337 sq. feet.	Fire-box	46¼ in. deep at back.
Total heating surface	1453 sq. feet.		

GENERAL CONDITIONS.

Train composed of 8 loaded, and 15 empty freight cars, with caboose. Average per loaded car 40,000 lbs., and per empty 19,000 lbs.

Diagrams taken with engine on regular local freight, run under ordinary circumstances.

Maximum grade 60 feet per mile. Average grade 40 feet per mile.

Vertical scale of diagram 60 lbs., per inch.

Indicator, Tabor.

PLATE No. 40.

Diagrams 1 to 7 were taken with a "Tabor Indicator," and No. 8 with the "Crosby Indicator."

You will see that in the cards made with both classes of indicators, the result is practically the same.

This engine is equipped with steam reversing gear, which I consider an advantage, enabling an engineer to handle his train in the most economical manner.

I desire to call your attention especially to the fact that no special arrangements were made in regard to taking these diagrams, it being my wish to show exactly the working of the engine on her regular run, and working under ordinary circumstances. This refers to diagrams for both passenger and freight engines, but with regard to sheet No. 4, the engine was pulling a light train, and I was not able to get the diagrams in consequence, that I would have liked.

Diagram No. 1, Plate No. 40, was taken while ascending a grade, and the brakes were set on several cars to enable me to work the engine to nearly her full capacity; the others were taken under ordinary circumstances. The dimensions and general conditions in all cases are given on the diagram sheets, and it is therefore unnecessary for me to refer to them here, except to state that all engines, with the exception of 36 were built by the "Baldwin Locomotive Works Co.," the 36 being built by the "Danforth Co."

The life of the link motion is largely a question of adequate bearing surfaces, the truth of which any railroad mechanic will admit. When the link had a face of but two inches, driving valves over ports 16 or 17 inches long, they wore rapidly, but when links having a face of 2½ to 3 inches were used to drive the same valves, the wear was greatly reduced.

The use of large cylinders and valves of late years, has made the balancing of the latter a necessity. Unbalanced valves have been frequently known to cut ⅛ inch from seat in 100 miles, while it is common to face an unbalanced valve every two weeks if the surfaces are not composed of first-class metal, as is very liable to happen in the construction of a cylinder. As an example, we had two engines in service on the Cincinnati Southern Railway that had to be faced up once a week, until we introduced the "Margach"

balance, since which time they have given us but little trouble, except in the case of fastening the balance to the valve proper. Hence, in my opinion, the necessity is unquestionable of balancing locomotive valves of present construction.

The question of lubrication of valves is of as much necessity as that of balancing, and the only rational means of lubrication is a constant flow of oil to them in small quantities.

While I am free to admit that cylinders constructed with proper iron in valve seat, and valve receiving necessary attention from man in charge, have given us service of from 8 to 10 months without facing, the great majority of our engines requiring facing in much less than 5 months.

We have in use the "Margach" and "Richardson" balance, both of which are good, but the "Richardson" balance has given us decidedly the least trouble. While I do not consider either of them perfect, I beg to ask your consideration of both, with a view of obtaining a perfect balance.

The proportions of the valve lap are made to vary largely by different master mechanics. We have found the best results from passenger engines with ⅞ inch lap, line and line inside, 5½ inch travel of valve, and with the same dimensions of valve on freight engines ⅛ inch inside lap, although some of our divisions have grades 60 feet to the mile and curves of six degrees.

I beg to deviate for a moment from the subject of valve motion, and call your attention to the capacity of boiler, which is so closely associated with the subject of valve motion.

I have no doubt but that there are many members of this convention who have, as well as myself, at some time of their lives, run a locomotive, and who will agree with me in the following observations. In the manipulation of all classes of locomotives built in the United States, of which I have had more or less experience, I have never found a boiler to generate sufficient steam to work the cylinders up to full capacity under all circumstances.

A heavy percentage of accidents have occured to railroads from this cause, engines stalling, doubling grades, etc., on one day, with a train they might pull on another occasion. This, in my judgment, is invariably caused by the proportions of the boiler being too

8

closely based on a scale assumed to be in proportion to the size of the cylinder.

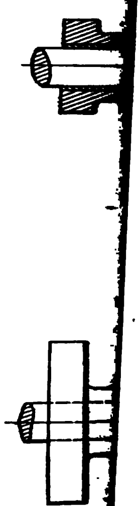
When an engineer finds himself in a tight place with a heavy train, and the boiler fails to give the necessary pressure, he will cut off the supply of water, and should he succeed in getting over his difficulty he is compelled to call on a heavy water supply to overtake what he has lost. This always has a cooling effect on the boiler and operates against the steam generating qualities, until a high pressure temperature is again reached, incapacitating the engine in the meantime from its maximum work.

I believe that the too small proportion of size of the boiler to cylinders by mechanical engineers, is caused by their objection to an elevation of the center of gravity, their endeavor being to keep the weight of the engine as low as possible, thus preventing them in many cases from making the boiler sufficiently large for obtaining the capacity required; and this defect is apparent in most of the engines constructed at the present day which are pulling heavy passenger trains.

In case of a spring hanger breaking, the boiler would drop down on the revolving driving wheel; but by elevating the boiler, which in my judgment is not objectionable, this difficulty can be overcome and a boiler of sufficient capacity could be given to the cylinder for abundance of steam under all circumstances.

We have now in service eight locomotives of this description, 18x24 inch cylinder; cylinder part of boiler 54 inches in diameter, center being 7 feet 3 inches and crown 9 feet 6 inches from the top of rail; we are able to get 1457 feet of heating surface from this boiler, and our engines will maintain a pressure of 145 pounds with poor quality of coal. They are doing remarkable work, pulling a local train of six to eight cars between Cincinnati and Chattanooga, distance 339 miles, making eighty stops and dead time of fifty minutes in addition, in 11 hours and 40 minutes, and it is a common occurrence for them to make up 40 minutes. You will see that the time is remarkable on this run, taking into consideration the grade and curvature, the maximum grade being 60 feet to the mile, average grade being 40 feet, maximum curvature being 6 degrees.

Again regretting that circumstances have prevented me from



regular service for 24 months without the steam chest cover being taken off, and on opening the steam chest, both the cylinder face and the steam chest cover were in good condition. No doubt good workmanship is required with these strips if we are going to have a successful balance valve. You must mill out the grooves in your valve so as to be perfectly true and the strips themselves must be carefully fitted and never less than 1¾ inches, and if possible get them 2 inches. Get them as deep as you can without choking the exhaust chamber of your valve. I presume on the Allen valve you can do that without any difficulty. Cut a very deep strip, and when the valve is in place the strip should not stand above the valve over 1-16 of an inch 1-32 is quite enough. There is a tendency to leak until after one or two months' working. I have had two years use of a valve of that kind without having broken a steam chest joint, and then not finding them in good condition is exceptional, and I do not think that is as good as the average. It is a successful balance valve.

MR. MORRILL—I have had about four years' experience with about the same as the Richardson valve. Mine was the Morse valve on an engine now in the shop. She has run 166,000 miles and the seats are not faced yet. She is running as a passenger engine, 16x22, 5½ foot wheel. The joints on the corners are different from the Richardson valve.

MR. WOODCOCK—What diameter do you make these springs that you are putting under the strip, and how high do strips project above valve?

MR. MORRILL—About one-eighth of an inch, so that the strips will lift 1-16 above valve. I don't know but what 1-16 in. spring would do it

MR. WOODCOCK—I should like to state that the engine that will take the train to Beach Haven will have that valve, and if any members want to get on the engine and see the pressure carried and how she handles under steam, they can do so. I think they will find it very satisfactory. An air valve in connection with this arrangement adds to its success, admitting air inside the steam chest.

MR. BLACKWELL—I would also remark that without an air relief valve, you will have very little success with the Richardson valve. The air vacuum valve is a necessity if you expect them to run for any length of time.

MR. A. G. EASTMAN—I have some heavy passenger and freight engines equipped with the Richardson valve, and they have done excellent service. Some have been in use a little over a year and some for two years. The ones that have been in service two years have been faced, but the others have not, and Mr. Barnett's remark brought to my mind a case that I saw while in Stratford, on the Grand Trunk, two or three

years ago. I saw a steam chest opened there before the general foreman, or division master mechanic, Mr. Patterson, who told me it had run 126,000 miles. The seats were very nice indeed, and I think they were not going to face them at that time. I do believe there is virtue in balancing valves, as it decreases the wear on our links, our knuckle joints, and makes the engine very much more easily handled, which is an item that our engineers will appreciate, as he is inclined to do as little as possible. I think we should investigate it and equip our engines with it.

MR. PRESIDENT—I believe Mr. Twombly, who is present, has had a good deal of experience with the balance valves, and if he is willing to do so, I would like to hear from him.

MR. TWOMBLY—Mr. Morrill has given you about all the information there is. I can say nothing more. These last cylinders that we are building now, we could not keep the seat on more than one trip, and now we run them eight or ten months.

MR. PRESIDENT—I would like to ask him what patent it is. Is it known as the Richardson?

MR. TWOMBLY—No; it is known as the Morse. Mr. Morrill got it down at Portland. Being acquainted with Mr. Morse, he got the privilege of putting in two or three of those valves, and from that we have gone on and made general use of it.

MR. SETCHEL—Is there a patent on it?

MR. TWOMBLY—I think not. The patent has run out.

MR. BLACKWELL—I would like to ask a question from the gentlemen who have used balanced valves, what description of spring they have used to keep the strips up, which they have found to be so satisfactory, spiral brass spring, or flat steel?

Mr. WOODCOCK—We used spring steel No. 22, overlaid spring, just enough to keep it up.

MR. BLACKWELL—Spiral spring?

MR. WOODCOCK—No, flat. We use that same style of spring, half elliptic overlaid style, on both ways of the length. They have worked very well. I think better than the spiral.

MR. JOHANN—I tried to use them and could not get them to work right. Will Mr. Morrill be good enough to have a drawing made of the valve to be embodied in the report. If it is a good thing he ought to put it on paper so that we can thoroughly understand it, and I would be very much gratified if he will do that in this case.

MR. SETCHEL—I want to ask any member who can answer it why they regard the air valve as necessary. Mr. Barnett states that it is indispensable, and that in order to be successful it must be used.

MR. BARNETT—I have had no experience with the Morse balance as applied to the Allen valve. I have simply applied it to the ordinary slide valve, and especially adapted to a steam chest not originally designed to have our equilibrium valve in it, and in putting the valve in you practically fill the steam chest, and when you shut off the movement of the valve create a vacuum in the steam chest, and ashes and dirt from the smoke arch rush in and cause the valves to chatter and to prevent the damage that resulted from it, I put in the air valve and then all the trouble we had ceased. I do not know that I can give any other explanation of it. I only know that the application of the vacuum valve—for it only happens when there is vacuum in the steam chest—relieved us of all our trouble. There was no chatter in the valve and everything worked smoothly. I never really got to the bottom of the trouble or what caused it, but I know we got rid of it, and made a success of it in this way.

MR. BLACKWELL—Mr. President, I have looked into that matter pretty thoroughly myself, and if the convention will bear with me a few moments, I will give my explanation. I think it is generally conceded that in the ordinary slide valve the valve lifts from the seat when the engine is shut off to allow atmospheric pressure into the cylinder through the exhaust passage. The balance valve can not lift, and consequently the cylinder acts as a pump. It would pump something from the boiler through the steam pipe if you could get it, but it can't, so it creates a vacuum, which vacuum is always present, and, as Mr. Barnett has remarked, the air valve is very essential; and you might about as well reverse your engine when you shut off as to try to run a balance valve without a relief valve.

MR. JOHANN—I am perfectly well satisfied that there is a necessity for a vacuum valve. I was just going to remark the same as the gentleman just spoken, and I guess that that is where the colored individual is in the wood pile.

MR. BARNETT—I asked the question as to the jointing in the strips because the original Morse valve has simply a place on top for equilibrium strips, two long, two short, and diagonal strips at the corner, which made too many pieces at that point, too many joints liable to cause leakage, and was no doubt the cause of a great deal of the trouble we first experienced in the application. That is the style we use to-day, four pieces with coil springs underneath, two under each of the short strips, and four under the long strips, made of 1-16 inch coiled steel wire two inches long. We find the coil spring much more elastic and sensitive than elliptic or belt spring made of flat steel, and it does its

work from one year's end to another. The half elliptic spring is too strong at first, and tends to cut the end surface of the steam chest cover. By using coiled springs instead we save cutting the top cover to start with, and the springs keep their sensitiveness and the strips up to their work for a longer period.

MR. BLACKWELL—The trouble I have found has been the filling up of the pockets in which the spring sets with tallow, and consequently, after a short time, the springs become solid and will not work; and to get over that difficulty, I have recently been trying flat springs.

MR. MORRILL—That is the reason why we changed ours to the elliptic. They filled up quick in using tallow.

MR. JOHANN—I think we have had enough of this. I move that we close the subject.

Carried.

THE PRESIDENT—Best method and material for lubricating valves and cylinders is the next subject. This committee consists of Henry Schlacks, James Boon, and Harvey Middleton. The report is now in the hands of the Secretary.

The Secretary read the paper, which is as follows:

To the Members of the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee on the Best Method and Material for Lubricating Valves and Cylinders prepared a circular which was distributed by the Secretary with a view of obtaining in brief and comprehensive form as much information as possible from different roads throughout the country to enable them to make a report which would be of value to the Association. The following questions were asked:

1. What kind of lubricant do you use on valves and cylinders?

2. Have you made any experiments with other kinds of lubricants? If so, please state results obtained?

3. How is the lubricant applied; by self-feeders, cup on steam chest, or through pipes from cab? Please describe the device you are using.. If self-feeding cup, where is the best location?

4. Have you made any experiments with self-oilers? If so, please describe the different devices and give results of experiments.

5. What mileage are you getting with the lubricant you are using to the pint or pound?

6. What results have you obtained in the wear of valves, piston packing and glands with the lubricant you are now using, compared with others you have tried?

7. What, in your opinion, is the best method of applying the lubricant to cylinders?

8. If you are using a compound that is made of several lubricants, please give proportions.

In answer to the above questions please do not confine yourself to the questions, but give any facts or exact data you may have bearing on the subject.

Replies were received from twenty-six different roads, without, however, eliciting much information beyond an expression of opinion in a general way as to the merits of different lubricants used and the varying methods of their application. The statistics showing comparative results as to mileage and economy of sight-feeding automatic lubricators, and the practice of applying the lubricant at intervals by hand, which it was expected would be furnished in answer to the questions asked, were not received; but without having sufficient evidence to enable your Committee to come to any definite conclusion, there is reason to believe some light has been obtained that will indicate the direction in which improvement is to be anticipated.

Of the twenty-six roads reporting, eight use tallow as a lubricant, while eighteen use valve oil.

Twenty-one have made experiments with lubricants; five have not made experiments.

Twelve apply lubricants exclusively through pipes leading from cab to steam chests, feeding at intervals by hand; fourteen, in connection with pipes leading from cab to chests and intermittent hand-feed, use sight-feed cups in cab, nine of which use in addition self-feeding cups located on chests.

Seventeen have made experiments with self-oilers; five have made no experiments; four not stated.

The following tabulated statement shows lowest and highest mileage to a pound of tallow or pint of oil, used for valves and cylinders in passenger service and in freight service, as obtained in ordinary practice and the different experiments made:

Class of Service.	Lubricant.	METHOD APPLIED.	Lowest mileage to lb of tallow or pt. of oil.	Highest mileage to lb. of tallow or pt of oil.
Passenger.	Tallow.	Pipes from cab, intermittent hand feed.	55	60
		Self feeding cups on chests	52	100
Freight.	Tallow.	Pipes from cab, intermittent hand feed.	26	40
		Self feeding cups on chests	18	31
Passenger.	Valve Oil.	Pipes from cab, intermittent hand feed.	43	114
		Sight feed in cab through pipes to chests.	59	206
Freight.	Valve Oil.	Pipes from cab, intermittent hand feed.	30	85
		Self feeders on chests	35	59
		Sight feed in cab to dry pipe . . .	48	100
		Sight feed in cab through pipes to chests.	55	125

As to the effect of tallow on wear of valves, piston packing and glands, four have obtained good results, six have had bad results, and sixteen have not stated their experience.

With valve oil seventeen have had good results, nine have given no information. None of the reports received mention any bad effects resulting from the use of valve oil.

Many different opinions are expressed as to the best method of applying lubricants to cylinders. Of the twenty-six replies received to the circular, nine have not expressed any opinion on this point. Of the remaining seventeen, eight prefer sight-feed cup in cab feeding through pipes to the steam chests; six consider pipes from cab to chests feeding at intervals by hand the best; two favor sight-feed cup in cab feeding directly to dry pipe; and one has obtained best results with self-feeding cup directly on chests.

With exception of one road the valve oils used are those brands purchased in open market, and generally known throughout the country. The valve oil used by the Ohio & Mississippi is one of their own manufacture, consisting of one part tallow and two parts Virginia Oil, costing 30 cents per gallon, which gives good results as to wear of valves, piston packing, etc., with an average of 67 miles to a pint for passenger and freight service; the oil being applied at intervals by hand, through pipes leading from cab to steam chests.

The objection generally advanced against the use of tallow is its corrosive effect upon the surfaces of the valves, steam chests and

cylinders exposed to its action, resulting probably from acids and adulterations found in refined tallow of ordinary grades. It has been observed by your committee that the roads on which good results have been obtained from the use of tallow are those in the Southern States, which are able to secure an abundant supply of pure country tallow that has not been subjected to the manipulation of a refining process. On one road in North Carolina where tallow has been used exclusively, the original steam chests and cylinders of an engine which has been continuously in service for 28 years present no evidence whatever of corrosive action, and are still in good condition; other engines on same road being in equally good condition.

Were it possible to obtain pure tallow in unlimited quantities there would be little occasion for a discussion of this subject; but as few roads are thus fortunately situated, the lubricant best adapted as a substitute for tallow becomes a matter of importance.

The results obtained from the use of lard oil, aside from the closing up of exhaust openings by the accumulation of gum in the nozzles are, as a rule, satisfactory; but its cost is such that a cheaper oil is more desirable.

Of the many kinds of oil technically known as "valve" or "cylinder" oils, which are, at present, offered in the market, your committee are not prepared to express an opinion as to which may be deemed the best; finding among those who have used them many advocates in favor of each different brand.

As to these oils it may be said they are the result of study an experiment on part of the manufacturers to produce a lubrica combining all the requisite qualities, at moderate cost; and fro the extent to which such oils have been introduced, the deducti is a reasonable one that their efforts have been successful.

With reference to the best method of applying lubricant to inders, your Committee find a variety of opinions, due chiefl varying conditions on different roads.

It is generally admitted that the old practice of applying t bricant at intervals by hand, through ordinary cups located di on steam chests, is a crude and wasteful method, unsatisfact its results, and on most roads has been abandoned.

The next step was the location of the oil cups in cab, connecting with pipes leading to the steam chests. This arrangement enables the engineer to exercise direct supervision of the amount of oil used, and overcomes many of the objections to outside oiling. On many roads it is considered the best method of applying the lubricant; but your Committee has observed that where such opinion is held there has been little or no experience with the more recently improved automatic oilers.

It may be stated that the objection to all methods of hand feed rests in the fact that while an engine is in motion reliance is necessarily placed on the care and judgment of the engine men to feed at proper intervals the least amount of oil required to maintain thorough lubrication. They must not neglect this duty; and to obtain the best results they must possess a sufficient degree of intelligence to use only the proper quantity of oil each time the feeding is done.

The introduction some years ago of the automatic cup or self-oiler located on the steam chests, and feeding the lubricant continuously, was an improvement which, however, did not meet all the requirements. Depending for its action on the condensation of steam, and being exposed directly to the effect of changes in temperature, it was found in extreme cold weather the water within the cup would freeze and stop its operation. Many expedients to overcome this trouble were resorted to, but without much success, and in consequence of its unreliability in cold climates, this cup has in a great measure passed out of use. In the south, where this difficulty is not experienced, the cup is still considered on many roads well adapted for the purpose.

The latest improvement in the method of applying lubricant to cylinders, is found in the sight-feed automatic cup located in cab, and feeding oil either directly to dry pipe, or through small pipes to the steam chests. The action of this cup is continuous, the oil contained within it being displaced by condensation of steam taken from the boiler. The feed, in plain sight, admits of perfect regulation, and when set to the proper amount the cup continues its operation automatically, drop after drop passing from it until the supply of oil is exhausted.

Your Committee have not received statistical information concerning the performance of the sight-feed cup on other roads to an extent sufficient to warrant a statement as to its economy in general use; but from experiments made by the Chairman it was found that the sight-feed cup gave in passenger service 80 per cent. better mileage, and in freight service 47 per cent. better mileage than the best results obtained by hand-feed through pipes from cab leading to chests.

The opinion held by a few members of the Association that the feeding tube from automatic cup located in cab should lead direct to dry pipe does not find favor with your Committee, it being considered more desirable that the lubricant should be supplied in certain quantities to each valve and cylinder, rather than to depend upon the chances of its taking that course at the junction of the dry pipe with the steam pipes.

In conclusion your Committee would give it as their opinion that the leading brands of valve oil are well adapted for the lubrication of valves and cylinders, and are at the present time the best lubricant available for the purpose in quantities sufficient for general use.

The best method of applying lubricant to valves and cylinders in their opinion is the automatic sight-feed cup located in cab, and feeding through pipes to steam chests.

Respectfully submitted,

H. SCHLACKS,
J. M. BOON,
H. MIDDLETON,
Committee.

THE PRESIDENT—You have heard the report of this committee as read by the Secretary. What disposition will you make of it?

MR. JOHANN—I move that the report be received.

THE PRESIDENT—It is moved and seconded that the paper be received. All in favor of that will say aye.

Carried.

THE PRESIDENT—The subject is now before you for discussion.

MR. LAUDER—I am loth to see this subject passed by without a little discussion, in-as-much as this question of automatic lubrication with

sight-feed apparatus is new, or comparatively a new one, and I think it ought to be investigated. Perhaps some valuable information can be obtained from those who have had experience with the so-called automatic sight-feed cup. I presume that I have seen as much of the working of these as any one, and I think I was the first man to put on one of the Siebert lubricators. I am aware that there are several in the market that embody perhaps the same principles that the Siebert does, but the Siebert happened to be in my section, and I put one on. I think the first Siebert cup that was ever constructed is running to-day, and has been running continuously, and giving, as far as I know, satisfaction. Since then there has been a variety of cups manufactured for the same company, to meet the ideas of different men. The first one that I put on was fed into a dry pipe. That was objectionable. Then afterwards they were made to feed through an ordinary oil pipe, and that, in my opinion, is the proper way of lubricating a valve. After several years of experience with the different methods of oiling, I am strongly in favor of using the automatic cup, located in the cab, under the eye of the engineer, with a sight-feed. I know that passenger engines with 17x24 cylinders can be lubricated properly with very much less oil than is ordinarily used. I have some now that have run upwards of 100 miles to a pint of oil and in good condition, and run for months without any appreciable detriment in any way to the wearing surface of the valves, and I think it is the coming way of oiling valves.

I would state that I was in Albany a short time ago, and while there I was shown an oiling arrangement substantially like the Siebert lubricating apparatus. It was, I think, the Swift, but I think they got their right to use the sight-feed from one of the two companies named. He had two cups, one for each cylinder, which held a pint. They were making on a passenger engine the round trip from Albany to Hartford and back with one filling, which would be 262 miles, I think, with a quart of oil. Now if such results can be got by the use of automatic lubricators, it certainly will pay, in a mechanical point of view, to apply the automatic lubricator principle to the oiling of our valves. I think that all or any of these automatic lubricators, the Detroit, the Siebert, or even the Swift (the one that I spoke of, which, I suppose, pays a royalty), but the one or the other of these will give over 100 to 150 miles' use to a pint of oil. I have no doubt that one pint of oil would be sufficient on any service to give 150 miles.

MR. HATSWELL—In the matter of sight-feed lubricators, the last year we have had considerable experience with them. A person came along about two years ago. I objected to lubricating the valves of cylinders

through a dry pipe for the reason that the packing would become loose, and the valves get on one side, and the other side would get all the oil. Nevertheless, we put it on, and it has worked very satisfactorily. I talked the matter over with the manufacturers of the cup, to get up a cup to feed both sides, one on each cylinder, and to feed into the oil pipes. One was gotten up, and I think we put the first one on that they got out of the shop. Since that time, we have put on about 60, and they are working very satisfactorily indeed. We had three engines running, 16x24 cylinders, that make 21 stops in 90 miles, and these three engines, running 520 miles with one quart of oil, the steam chest covers have not been up from one of them in ten months, or since the cups have been on. That is what we have been doing on our road.

MR. SETCHEL—I don't want to trouble this meeting, or prolong this discussion any more than necessary, but, so far as we are concerned, we have made a radical departure within the last year in regard to this matter of lubricating the valves and also as to the material used. We have at this time 12 sight-feeders and they work exceedingly well, giving perfect satisfaction to the engineers so much so that the first one that was put on it being a little different from the standards afterwards used and adopted, we sent a man out to the engine to change it, and the engineer under the impression that it was going to be taken off said that he would rather pay for it out of his own pocket than have it taken off his engine. Well, engineers are generally prejudiced about new things and where a man sees so great an advantage after running the thing three or four months as to offer to pay for it out of his own pocket he is pretty well convinced of its utility. It seems to me to be the only correct method of lubricating a cylinder, continuously drop after drop, and yet I have thought that there might be an objection to the use of sight-feeders on some engines, for instance on a switch engine in a crowded city where you are required to switch in the streets with your cylinder cocks shut, and not allowed to open them. There is a slight accumulation of steam from this sight-feeder in cylinders and we all know how much harder it is with a large valve, to reverse the engine with steam in the cylinders and I have thought there might be on this account an objection to using it on such engines. But I am not sure of that. I have never yet had it in that service. There is another very great advantage in using a sight-feeder and that is in the kind of lubricant you can use. You can use a cheaper quality of oil. After a good deal of discussion on this point as to what was being used in the country, and after writing to the leading roads and getting their answers we tried an oil called the "Matchless Valve Oil" and it gave very good results notwithstanding

there was a great opposition at first from engineers. They claimed that the valves worked badly and rattled and they were afraid that the links would be torn off but they were not, and after they got to using it they found it worked just as well as tallow.

Well, taking the cue from this, and after a careful examination of this mixture and talking with a great many oil men, I could see no reason why just enough tallow to lubricate the cylinders of good quality, and just enough of oils to fill up to make in quantity what the engineers wanted, would be just the thing for cylinders. So I decided to try a mixture of one barrel of tallow and two barrels of Virginia oil mixed together, and aside from the opposition that we always meet from locomotive engineers when you change the lubricants or change any device, we have had no trouble with it at all, and we are using it to-day in sight-feeders and in cup feeders and in Nathan & Dreyfus feeders and it works splendidly. We have no trouble with it at all, and it only costs us from 25 to 30 cents a gallon.

THE PRESIDENT--Are there any further remarks on this subject?

MR. LAUDER—I move that the discussion on this subject be closed.

CONING OF THE TREAD OF WHEELS.

MR. SETCHEL—The report of this Committee consists of letters to a large degree inserted numerically according to the number of the questions asked and I am afraid I cannot read it so that it will do you any good and unless the Committee object to it I would move that this be printed and the reading of it omitted at this meeting.

MR. LAUDER—Before the motion is put I would like to hear from the Chairman of the Committee, Mr. Brownell, whether the Committee would be willing to have the reading of the report dispensed with on account of the limited time, and the report to be incorporated in our proceedings.

MR. BROWNELL—It would be satisfactory to me. The drawings and blue prints that I have received from the different members are all on exhibition here where they can be seen. We have received some 25 replies from the circulars we sent out and some from mechanical engineers that we think most of the members would like to have printed.

MR. LAUDER—When a committee has been to the trouble to prepare an elaborate report it seems like discourtesy to pass over the reading of it at the annual meeting; but in this case the information in the report is of such a character that I don't think there would be any benefit to the Association to have it read, and if it is printed in our Annual

Report it will serve the object for which we are here and for which we expect duty from the Committee and in-as-much as the Committee are perfectly willing that we should dispense with the reading of it, I will move that the reading of the report on coning of the wheels be dispensed with.

THE PRESIDENT—With this explanation the motion is that you dispense with the reading of the report on coning of the tread of wheels. All those in favor of this motion say aye.

Motion carried.

THE PRESIDENT—The report will be printed and such diagrams made as the Supervisory Committee think necessary to go with it.

BURLINGTON, VT., June 5, 1884.

To the American Railway Master Mechanics' Association:

MR. PRESIDENT AND GENTLEMEN:—Your Committee appointed to ascertain the desirability of using or coning the tread of railway wheels beg leave to submit the following:

In order that the association might receive a general expression of opinion on the subject, there was mailed to the several Master Mechanics and Superintendents of Motive Power printed circulars asking replies to the following questions:

1. Do you use cone tread wheels, and to what extent?

2. Do you use any with straight tread, or any portion straight? If so please describe.

3. How much taper to the inch in diameter of wheel do you use, and how much would you recommend?

4. If you recommend straight tread, would you turn them wholly or cone outer edge, and to what extent?

5. Do you think there is any benefit derived in coning wheels for curves?

6. What has been your experience as to the difference in mileage or durability, between straight and cone tread wheels of same quality and similar service?

7. If convenient, send drawing of both the straight and cone tread wheels you use, and also drawing of same after they are worn out, if possible.

8. Do not confine yourself to the questions given above, but give your experience and opinion in full.

As it is our desire that the members of the Association may be thoroughly conversant with the results of our inquiries, we have concluded the better mode to be to report, without condensation, each reply we have received, and they are as follows:

DELANO, PA., March 21, 1884.

F. G. Brownell, M. M., Chairman:

DEAR SIR:—The enclosed sketch (see plate 45) is the standard tread adopted for all steel-tired wheels by the M. M. of the L. V. R. R. As it is about one year that we have been turning steel-tired wheels as per sketch, I can not say whether it is the right principle or not. It will, no doubt, be all right for locomotive driving wheel tires, as they very soon wear to suit the head of the rail, but for all leading wheels our experience is in favor of the coned wheels.

Yours truly,

THOMAS CAMPBELL,

M. M. Lehigh Valley R. R.

MR. GEORGE RICHARDS, M. M., of the Boston and Prov. R. R., answers the questions in the circular as follows:

1. All wheels are coned.
2. None.
3. About three-eighths in diameter to length of tread.
4. If straight, would cone the overhanging about three-eighths inch.
5. Only so far as it puts off channeling.

TRENTON, MO., March 21, 1884.

F. G. Brownell, Chairman:

Your favor asking information in regard to tread of wheels is at hand.

1. We use nothing but cone tread wheels.
2. We use no straight tread or any portion straight.
3. We use all J. H. Bass wheels cast at our shop in Chicago, but do not know the taper.
4. As we are only using the cone tread wheels, I can not state experience on this subject.
5. I do think there is quite a benefit to be derived from coning wheels for short curves.

I commenced turning tires on our Mogul engines with two and a half degree taper, and increased it to three and one-half degrees, but my experience leads me to think that three degrees on my Moguls works best. I have tapered our blind tires the opposite from flange tires, the smallest inside, but have abandoned it, and I think a straight blind tire the best.

Our railway is quite crooked, and I have been bothered with cutting flanges on forward tires.

My 8-wheeled engines are giving good satisfaction with tires turned two and one-half degrees taper. Although I am running some few turned three degrees taper, this subject is one that I am very much interested in, as my road is full of short curves, and I have charge of 18 Mogul engines, I hope the question will be talked over at our next annual convention.

6. As I have no straight tread wheels I have nothing to say.

7 and 8. I have nothing to communicate.

Yours truly,

R. O. CASCADDIN,

Div. M. M. Chicago, Rock Island & Pac. R. R.

MR. J. M. LEVIS, M. M. Cin., Selma & Mobile R. R., answers as follows:

1. Use them exclusively.
2. No, sir; not yet.
3. One sixty-fourth full.
4. Cone outer edge.
5. Yes, sir.
6. Have had no straight ones to compare with.

OTTAWA, ONT., March 24, 1884.

HON. D. C. LINSLEY, Manager Canada Atlantic Ry., answers as follows:

"We do not use cone tread wheels on the Canada Atlantic Ry., having no curves of less than 2,600 feet radius; have used them on sharp curves, and upon such curves consider them far preferable to straight tread."

LOUISVILLE, KY., March 27, 1884.

F. G. Brownell, Chairman, etc.:

DEAR SIR:—In reply to the questions of the circular of your Committee, I have to state:

1. Yes, exclusively, except a portion of the face on driving wheels is straight for two inches from the flange, and from that to the edge is tapering.

2. Only driving wheels, as stated above.

3. The taper, in diameter, is one-fourth in four inches of width of face, or one-eighth from straight in four. It seems to me the above is about right for a taper face on cone wheels.

4. I think straight face for two inches from base of flange, and then taper from that to the edge to about one-fourth smaller in diameter at that point, would be a good form for the face of the wheel, and better than if coned all the way on the face. There is an objection, however, to a wheel of this shape. When the wheel passes off the tongue of a frog, this taper on the outer edge permits the wheel to drop until the outer edge of the cone comes on to the face of the wing rail, and in passing on to the point this cone or taper on outer edge allows the flat part of the face to be lower than the bevel of the top of the frog point, consequently the tread of the wheel, when straight, will strike the frog point a harder blow than if the taper extended all over the face. As the face of the wheel wears it will in time become flat or straight, when this difficulty referred to will cease to exist. On the whole it seems to me that the flat face and coned outer edge would give the best results. The object of the coned edge is that good effect will be manifested when the wheel becomes worn down so that, instead of becoming hollow at the center and high at the outer edge, when worn down it will be nearer a flat or straight face.

5. Nothing of consequence, provided the face of the wheel did not change to a hollow next to the flange from wear, as it soon would do if made without any cone when new. A coned wheel, however, is better than one largest in diameter at its outer edge, one coned in the reverse way as they often are by wear. If a wheel is flat on its face when new, the cone in the wrong direction would be excessive before worn out, but if it begins with a cone in usual

way or right way, the cone in the wrong direction, when worn out, will be of less extent than it would be in the case of a wheel beginning its existence flat on the face, and it is for that reason more than any other, that coned wheels have been used. The coned wheel wears towards a better shape, rather than wearing toward a worse one, at least until it is half worn out or more.

6. Can give no facts on this point from experience other than in the case of locomotive tires, which give a little more mileage before requiring turning, than they would if the face had not been tapered. But the per cent. of difference I can not give. It can not be, however, very much. It might be as much as 10 per cent., but in the case of steel tires, due to the shape of the face of the wheel when new, or after turning, I think not more than 5.

I am sorry that I am not able to give you more definite information on the points referred to in your circular, but I have had no experience with chilled cast iron wheels, with part straight and part coned face. Yours truly,

REUBEN WELLS,
Supt. Machinery, Louisville & Nashville R. R.

BOSTON, MASS., March 29, 1884.

Mr. F. G. Brownell, Chairman, etc.:

DEAR SIR:—In reply to your circular I will confine myself to the Question No. 8 altogether.

A pair of wheels, equal in diameter, fixed to one axle and made to roll on a common road, will both revolve at the same space. The pair of wheels must also roll in straight line, or else one or the other wheels must slip on a curve. The outer wheel has farther to travel than the inner wheel, and if the wheels be fixed on axle, it is plain, unless they are of different diameter, a great deal of slipping will ensue. The tread of railway wheels was coned to lessen, if not to stop, this evil. The centrifugal force, it was thought, would push all the wheels outwards. This would cause all the outside wheels to revolve probably on a larger circumference than the inside wheels. Practically this action takes place to a very limited extent, because railway axles are kept parallel to each other in rigid frames. Therefore, when the leading wheels of a truck are

rolling forward and bearing sideways against the outer rail of a curve, the trailing wheels, being parallel, are bearing sideways against the inner rail. Coning wheels is, therefore, of no practical benefit on curves.

Coning wheels, however, may cause each pair of wheels to assume a central position on the track, and so diminish the grinding of the flanges against the rail. It seems, however, incorrect to make a cone continue to revolve in a straight line. Coning wheels has one great advantage. It gives a greater thickness of tire on that portion of the tread which is subject to the greatest wear. In this way wheels coned at the tread become approximately straight as they wear away.

A wheel with a conical tread takes much longer to wear to an objectionable shape than one with a straight tread. I think highly of a tread made as per sketch attached (see plate 46). This combines the benefit derived from both straight and cone tread.

Yours truly,

C. BERKLY POWELL,

M. M. Old Colony R. R.

NEW YORK, March 19, 1884.

Messrs. F. G. Brownell and Others, Committee, etc.:

GENTLEMEN :—I am in receipt of your circular containing questions in reference to coning the tread of wheels for railway purposes, to facilitate the passage of a car on a curve.

As I am not in charge of any particular railway, or directing the movements of cars, I can not speak of actual results, and must confine my answers to the philosophy of the matter and a common sense view of it.

I would premise by saying I believe the whole sytem of coning the tread of railway wheels is a very pernicious practice, and it was advanced in the very earliest period of the railway era by De Pambour, a French lieutenant of scientific education and very little experience or knowledge practically.

The same may be said at that time of all railway men. But we of our day must admit that De Pambour was a clever man in philosophy, as well as in experiments, and that, with the exception of a

few French refinements in mechanical arts which were of no practical value, we owe to him a large debt of recognition for what he did of value to the railway world as far back as 1836, when he made the valuable series of experiments on the working and power of a locomotive engine on the Liverpool and Manchester railway, assisted by my old friend, Edward Woods, who is now one of the leading officers of the Institution of Civil Engineers, of England.

Among the fallacies in mechanism which De Pambour saddled the world with, was the coning of railway wheels. It was a pretty theory at first sight, and was scientifically correct as to running curves if he could bring into play all the conditions necessary for its proper action, namely, uniform speed, so as to get uniform centrifugal force to act, also curves of uniform radius; also each axle in the car independent, for it is very clear that when two axles in a car are fixed parallel, and held so rigidly, all the conditions of the problem are disturbed, and their imaginary value rendered a unit.

How so clever a man as De Pambour undoubtedly was, could have overlooked the matter of parallel axles, and not having a common cone to the two as one, it is difficult to see; but then other clever and experienced railway men get befogged in railway problems, and remain enthusiastic admirers of a fallacy for years.

How sure we are to see some man come out every few years with a new patented invention of loose wheels on the axles of a railway car, by which he is going to run curves without any friction, and how sure he is to meet disappointment! Let any man take his four-wheeled wagon which has loose wheels, and nail the front axle parallel with the rear axle, and then see how much his loose wheel will help him round the corner of a street, and then he will begi to see the value of a loose wheel on the axle of a railroad ca Now for any man to satisfy himself of the value, say the merits a cone on the tread of a car wheel, let him construct a truck wi four wheels on two axles, and fasten the axles parallel in a fran Let two wheels on one side of the frame be three inches in diamet and the other two and three-quarters diameter, then put this tr on a floor and push it, and it will run in nearly a straight line; take one axle out, having one large and one small wheel on it,

start it on a smooth floor, and it will roll in a circle true to the frustrum of a cone, which the wheel represents.

I have a well-made model of this kind, and speak knowingly of results when experimenting with two axles parallel.

In discussing the matter of cone on wheels we must recollect that in early times, way back to 1830 to 1840, we in railway matters followed the practice of England, even to the rules and formulas of Rennie and Morin as to the friction on railways. In those days the practice usually was to put a very heavy cone on the wheels, and to key all the wheels on the axle.

This practice is persisted in on many railways in England to this day, and within a few weeks I have received from New Zealand, where they have over 1,350 miles of govenment railways, a drawing of their standard steel tire wheels as models to copy, showing counter sunk conical bolts put down through the face of the tire to hold it on. These fallacies, once introduced, are difficult to get rid of. The cone on wheels called for an inclined head to the rail, or to have the rail inclined, which was done with the rail on many thousands of miles of railway; so it became a very difficult matter to eradicate this pernicious fallacy of cone on wheels, and remains so to the present time.

The same may be said of other railroad fallacies, but, in my opinion, it is best to face a difficulty at once, and correct it, no matter what the cost may be.

We have all heard of the war of gauges, and what a fierce war was waged over that question; but common sense prevailed in England, and all the railways brought to one gauge. In June, 1840, there were nine railway gauges in use in England; and that was before the supreme folly of narrow gauges was introduced into England, from which country we got the seed planted into our soil, and grew the detestable contrivance here to the depletion of many a rich man's pocket.

We should thank Providence that this intolerable weed is dying out in a country where the people are not yet all pigmies in body or brain. There is among Americans naturally a vast amount of mechanical instinct, a faculty distinct from science or the result o education, a great natural gift. This gift was possessed by George

Stephenson in an eminent degree, and gave him faith in what he could do with a locomotive when all England was howling against him as a lunatic and full of conceit and folly. Scott Russell, when reading a paper before the Royal Society of England, about 1850, on wave lines for ships, and demonstrating by figures the merits and value of such lines, said: "The Americans have been for thirty years building ships on wave lines, but I doubt if any of them could demonstrate mathematically their value." He was right; they could not, nor could they say why. It was mechanical instinct at work, and it has been the same instinct at work for years among our engineers, trying to do away with a cone on railway wheels. They saw the cone, and they saw the rail inclined to meet it, but they never believed in it, and they have been getting rid of it little by little until it is reduced to a small quantity, and that, in my opinion, should be sent a trackless wanderer as soon as possible.

As first designed, it was a species of double wedge, driven by a five to ten-ton sledge, the chief operation of which was to spread the track, the result being loss of life. In 1856 the British Government sent Captain Douglass Galton, of the Royal Engineers, inspector of railways in England, to this country, to examine our railways and to report on them. Captain Galton is a man of marked ability, free from all prejudice, and his experience in the railway practice of every country in Europe and America is probably not equalled by any other man. His report on the railways of America is truthful, interesting, and impressive. Speaking of wheels, he says: "I found in the United States that they were making cylindrical tread to the driving wheels of engines, and since my return I find that the same has been done in Austria with good results."

Mr. P. H. Dudley, the inventor of that wonderful instrument, the dynograph, used for inspecting railway tracks, is a man of great mechanical ability, and has as good knowledge of railway machinery and railway economy in all its detail and workings as any man in this country. I am glad to find that he joins me in the opinion that all cone on railway wheels is detestable, and should be abandoned.

If, in casting chilled wheels, it becomes necessary to have some coning of the tread, to facilitate drawing the wheel from the mould,

let it be slight, say one in forty, a cone I have been using on many railways in South America with success for a quarter of a century.

I cannot see any reason or propriety in turning one part of the tread cylindrical and the balance conical, but I can see a great impropriety in it, for it will cut the crossing points badly when passing through the throats.

The sixth question of the circular can not be answered so that the answer can be of any value. As to mileage and durability of wheels, as the rail is inclined to fit a wheel that is coned will not fit a wheel that has a cylindrical head, and *vice versa*.

As the eighth item asks for opinions as well as answers, I will venture to give. As connected with railway economy, it is to use a heavy rail of best material, with a wide base and a wide bearing surface for the head, and splice the joint with a long sleeve of flat steel, so that it will be as strong at that point as at any other on the rail. And when we get a little more enlightened as to railway economy, and dare to go in the face of universal practice, let us take the sleepers out, and do away with transverse bearings, and put the rail on wide longitudinal bearings of metal, and bolt them fast, with a cushion of some kind between them.

I have the honor to be, gentlemen,

Your obedient servant,

W. W. EVANS,

Hon. Member of A. Ry. M. M. Ass.

MR. ALLEN COOKE, M. M. Chicago and Eastern R. R., answers the questions as follows:

1. All cone wheels.
2. None.
3. One-eighth to inch.
4. If I have to try straight tread would take off one-half on a side, and in one and a half inches nothing.
5. Think there is.

MR. G. W. BLANCHARD, M. M. Bennington and Rutland Railway, answers as follows:

1. All the wheels we use are coned tread.
2. No.

3. One-sixteenth to one inch in width of tread of wheel.
5. I do, to protect the flanges.
6. I have had no experience with straight tread.

MR. W. H. STEARNS, M. M., Conn. Riv. R. R., answers the questions as follows:

1. Mostly common cast iron cone tread.
2. About two and a quarter straight, and the remainder taper.
3. One-eighth to one inch.
4. Cone outer edge.
5. Very little.
6. Have not kept the mileage.

ST. PAUL, MINN., April 3, 1884.

F. G. Brownell and Others, Committee, etc.:

GENTLEMEN:—In answer to your circular in regard to coning wheels, I send you blue print, which will answer your questions, Nos. 1, 2, 3, 4, 7. (See plates 47—1, 2, 3.)

In answer to question 5, I do not think the benefit sufficient to cone wheels any decided taper.

In answer to question 6, I consider the turning of the tires as in sketch, with outer edge coned the most durable on account of the snow and ice in this climate, and the consequent slipping of wheels. I trust this information will be satisfactory.

Yours truly,

H. MIDDLETON,

M. M. St. Paul, Minn. & M. Ry.

ROANOKE, VA., April 8, 1884.

F. G. Brownell, Chairman, etc.:

DEAR SIR:—In reply to your circular of the 16th I beg to give you the following replies:

1. We use coned and straight tread wheels, about equal number.
2. Wheels with straight tread have section as shown in sketch herewith. (See plate 48.)
3. The section of wheels above referred to give good results.
4. Would make wheels similar in section to that recommended by Committee at Chicago, June 1st.
5. Do not consider that there is any benefit derived in coning

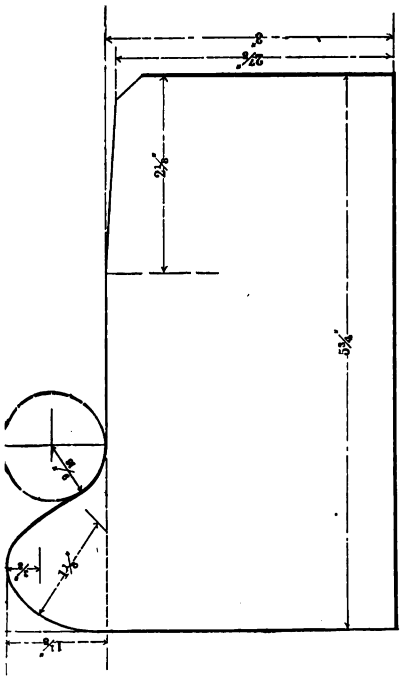


Plate 45.

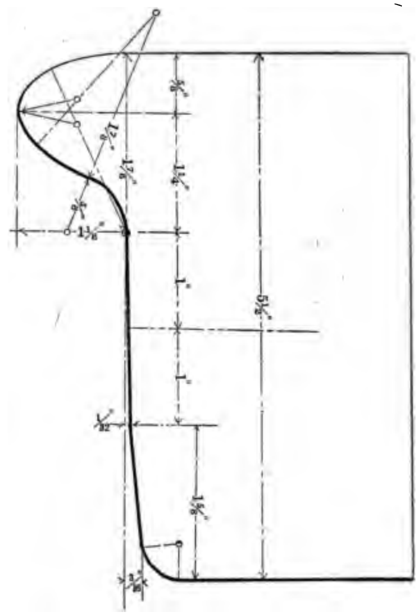


Plate 46.

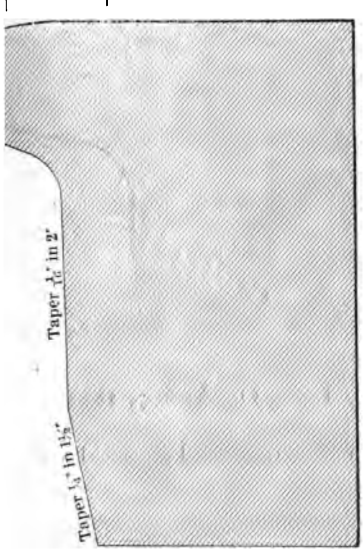


Plate 47—1.

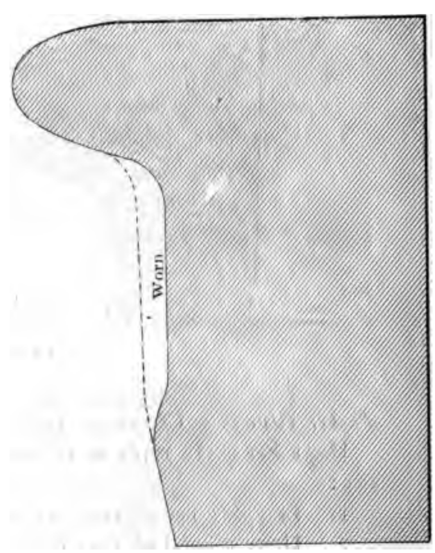


Plate 47—3.

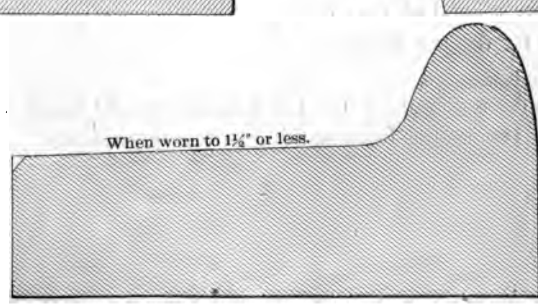


Plate 47—2.

wheels for freight trains. There is probably some advantage in coning wheels for passenger trains.

6. Have not had sufficient experience with straight tread wheels to answer this question.

7. Section of wheel enclosed.

Yours very truly,

CHARLES BLACKWELL,

Supt. Motive Power, Norfolk & Western Ry.

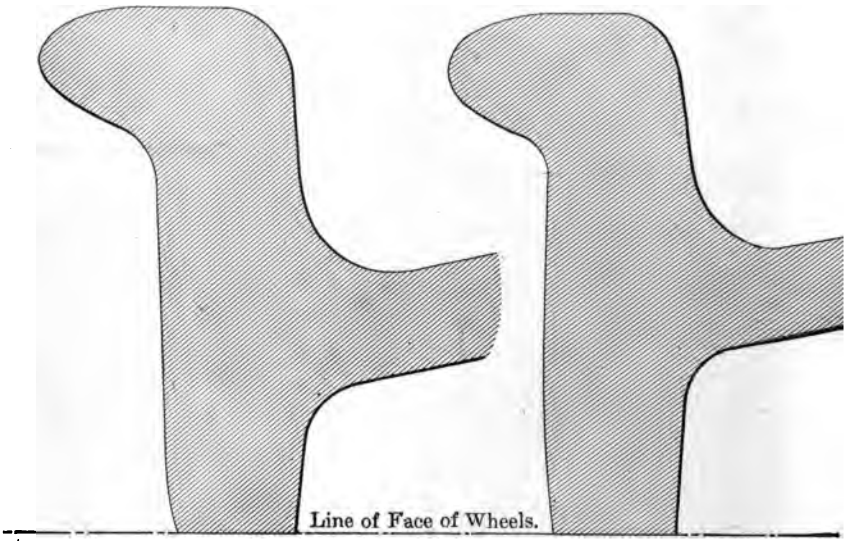


Plate 48.

LIMA, O., April 7, 1884.

F. G. Brownell, Chairman, etc.:

DEAR SIR:—In reply to questions under date of Feb. 16, I will say:

1. Yes, sir; use all cone tread car wheels.

2. Have turned all tires on engine drivers straight with champered edge for the last 14 years.

3. Not any.

4. Would recommend for car wheels straight tread, with cone outer edge two inches from nothing to one quarter inch.

5. No, sir.

6. Have had no experience except on driving wheel tires. In addition to above will say that coning of outer edge of tire of wheels is a large saving to frogs and crossings, and can be run much longer without being turned on account of tires being guttered.

Our road master considers it a decided improvement over coning the tires wholly.

In my judgment, with what experience I have had in the last 15 years as master mechanic, and 10 years on an engine, I would be in favor of all tires on driving wheels, with straight tread and coned outer edge.

Yours truly,

H. L. COOPER,

Supt. Equip. Lake E. & W. R. R.

MR. F. A. PERRY, M. M. Cheshire R. R., answers as follows:

1. Yes, all wheels we have in use are coned.
2. Do not use any.
3. About five-sixteenths in. to 33 in. wheel, with tread three and half to three and three quarters wide.
4. Should cone outer edge if I used them.
5. Yes, I think there is.
6. Have not made the test.
8. I think there should be uniformity in the cone of wheel tread, *i. e.*, all should be coned, or all straight for the good of the track.

EAST BOSTON, MASS., April 7, 1884.

F. G. Brownell, Chairman, etc.:

DEAR SIR:—In reply to the circular received from your Committee, regarding the coning of wheel tread, I would say that we use cone tread wheels on our rolling stock.

We use a taper of about three-sixteenths inch on all chilled wheels, and about one-fourth inch on steel-tired wheels.

I believe that the cone tread is the proper one for railroad service, and that there are many advantages over the straight tread, the most important advantage being the prevention of wear by slipping on curves, and the partial removal of the cause of sharp flanges,

and the tendency to keep on the rail and not go straight ahead, and jump it on meeting a curve.

To satisfy myself of the correctness of my opinion I have had several pairs of straight tread wheels put into service, but am unable as yet to make any comparison, as they have been in use but a short time. I would recommend the coning of chilled wheels three-sixteenths inch, and steel-tired wheels about a quarter. I would recommend that all leading wheels be coned not less than one-fourth inch.

Herewith please find tracing of our flanges for chilled, cone and straight, and also steel-tired wheels. (See plate 49.)

Yours truly,

A. PILLSBURY,

Supt. M. P., Eastern R. R.

MR. W. A. SHORT, M. M. Wisconsin Central R. R., answers the questions as follows:

1. Exclusively.
2. No.
3. One-sixteenth inch.
4. Never used straight tread.
5. Yes.
6. Have none.

SPRINGFIELD, ILL., April 17, 1884.

F. G. Brownell, Chairman, etc.:

DEAR SIR:—Answering your circular of Feb. 16, I would say:

1. We are using cone tread wheels entirely.
2. We are not using any wheels with straight tread, or any portion straight.
3. On our driving wheels we use an uniform taper of three quarters of an inch to the foot. On our cars and tenders we use just the taper sufficient to draw the casting from the chill.
4. I do not recommend straight tread.
5. I think that benefit is derived from coning wheels for curves.
6. Not having used straight tread wheels, I have made no experiments as to the wearing qualities of the two kinds of tread.

Yours truly,

JACOB JOHANN,

Gen. M. M. W., St. L. & Pac. R. R.

KINGSTON, PA., April 8, 1884.

F. G. Brownell and Others, Committee, etc.:

GENTLEMEN:—In answer to the circular sent out by your Committee I would say in reply:

1. We use the cone tread on all cast iron chilled wheels.

2. I have for the last sixteen years or more had all driving wheel tires coned for about two inches from outside edge of tread, the balance straight, and I have for several years turned all steel-tired wheels, including the Allen paper wheel, in the same way.

3. I use and would recommend from about three-sixteenths to one quarter to the two inches, or at an angle of about five degrees —that is, placing a straight edge on the straight part of tread and at a distance of two inches from the point of contact on the edge of the tire, the distance to tread being from about three-sixteenths to one-quarter inch.

4. I would certainly cone outer edge about two inches from edge.

5. Theoretically there is, but from observation I do not think there is much benefit derived from it.

6. Not having kept any record, I cannot give any data, but think the mileage is greater with straight tread, as the material turned off in coning is worn off in the straight tread.

Yours truly,

CHAS. GRAHAM,

M. M., D. L. & W. R. R.

CLEVELAND, OHIO, April 23, 1884.

F. G. Brownell, Chairman, etc.:

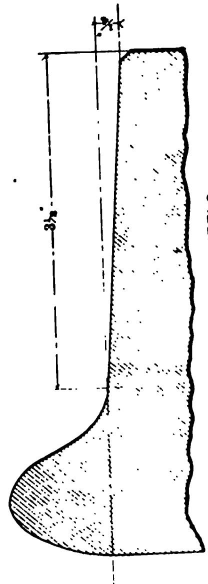
DEAR SIR:—In reply to list of questions sent from Secretary American Railway Master Mechanics' Association, I would say:

1. Generally.
2. None in use.
3. See enclosed drawing. (See plate 51.)
4. See enclosed drawing. (See plate 51.)
5. Have never made comparison.
6. Have no data for comparison.

Yours truly,

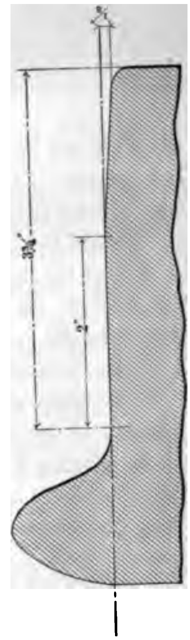
G. W. STEVENS,

Supt. M. P. L. S. & M. S. R. R.



STEEL TIRED WHEELS
Plate 49—1.

CHILLED WHEELS
Plate 49.—2.



STRAIGHT TREAD WHEEL
Plate 49.—3.

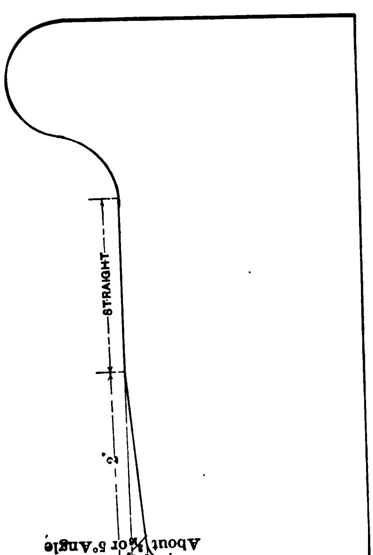


Plate 50.

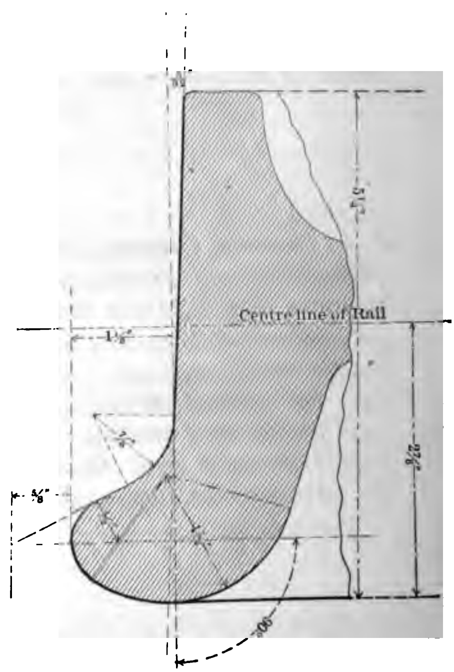


Plate 51.

CHICAGO, ILL., May 6, 1884.

F. G. Brownell, Chairman, etc.:

DEAR SIR:—In reply to your circular of February 16, I would say:

1. We use cone tread wheels entirely.

2. We do not use straight tread wheels and never have tried them.

3. We use a taper of five thirty-seconds inch per inch of tread, measured in diameter of wheel—that is, measured by calipers over the wheel—the incline of the tread of tires to the axle being five sixty-fourths inch per inch. I think conditions under which they run should decide taper.

4. I do not recommend straight tread.

5. I believe that an engine in rounding a curve crowds the outside rail, and that then coned wheels are a benefit.

6. Never having used straight tread wheels cannot answer.

7. Having no drawing of wheels that will be of any interest, as we cone nearly all wheels alike.

8. I think that on very crooked roads the wheels should be coned more than for straight roads. We have a number of Mogul engines which run on the most crooked division of our road. When built we gave them the same taper as the other engines. We soon noticed an excessive wear on the flanges. When the tires were turned again we gave them more taper—I cannot say just how much it is, but I think it is a little over one and a half times as much as usual—and the result was very satisfactory. We noticed no more unusual flange wear. I attributed the wear of the flanges to two causes, the long wheel-base and the crooked track.

I regret to say that I have never made any experiment in the coning of wheels, so that I cannot give you any data of value for your report. Yours truly,

THOS. TWOMBLY,
Gen. M. M., C. R. I. & P. R. R.

CLEVELAND, OHIO, April 30, 1884.

F. G. Brownell, Chairman, etc.:

DEAR SIR:—In reply to circular under date of February 16th, would say:

1. We use cone tread wheels altogether.

2. None.

3. One-sixteenth of an inch.

5. I think there is a benefit derived in coning wheels for curves.

6. I have not had any experience in straight tread wheels.

7. The only change we make here is on our tires for switching engines, of which please see blue print enclosed. We find that by turning the tires in this manner we get six months more service out of it before it is necessary to take the engine in shop.

W. F. TURREFF,
Gen. M. M., C. C. C. & I. Ky.

CHARLESTOWN, MASS., May 18, 1884.

F. G. Brownell, Chairman, etc.:

DEAR SIR:—In reply to your circular issued February 16th, I will say:

1. Nearly all the wheels in service have the usual cone tread.

2. Have none absolutely straight except plain driving wheel tires.

3. One-sixteenth per inch in diameter.

4. At the present time think favorably of coning one and three-fourths inch of outer edge, but am not yet prepared to give results from experiments.

5. There is apparently in the commencement of service, but the cone soon wears away.

6. Have not yet had experiments sufficient to give results.

8. My experience has been with coned wheels, but think favorably of coning to outer edge.

Yours truly,
G. A. COOLIDGE,
Supt. M. P. Fitchburgh R. R.

ST. LOUIS, MO., May 24, 1884.

F. G. Brownell, Chairman, etc.:

DEAR SIR:—Your circular of questions, under date of February 16th, has lain on my desk until this late day unanswered on account of press of business. I beg leave, however, to submit the following:

1. Yes, about 4,000 or say one-third of our equipment.

2. Yes, about 15,000 or say two-thirds of our equipment. The tread is straight from throat of flange to one and one-fourth inch of edge. The bevel one-fourth inch in four, which is done to protect the wing rail of frog, thereby preventing edge of wheel from breaking.

3. If wheels are coned about three thirty-seconds of an inch.

4. I would recommend them straight from throat of flange to within one and one-fourth inch of edge, then bevel to outer edge.

5. This is a very leading question and admits of a great deal of argument, but as far as my knowledge extends the benefit gained by a coned wheel on curves, if any, is lost elsewhere. There are several things to be taken into consideration in this connection, namely, can a wheel be coned to adapt itself to all degrees of curvature, to a straight line, a thirty degree and a sixteen degree curve? I say not. 1st. If in running on a straight line and having a play of three-fourths inch to one inch between flanges and rail, the wheels would necessarily, if both are the same size, keep a continual zig-zag motion, for as the truck will run towards one rail its wheel being larger near the flange would be thrown towards opposite rail, when the motion would be repeated and so on continually, consequently the wear would be greater on journals, wheels and rail, whereas with a straight tread and wheels exactly the same size there would be a steady straight motion. 2d. In going around a curve, say of from five to ten degrees, at a high rate of speed, a coned wheel would have a trifle the advantage if the tread of wheels is coned one-fourth inch from throat of flange to edge of wheel, tread being four inches. There would be about one thirty-second inch to one inch in diameter of wheel gained, or one-fourth inch in ninety-nine inches, the wheel being thirty-three inches in diameter, which would not be enough gain to prevent wheel slipping on say a ten-degree curvature. Hence, I argue no material advantage is gained, inasmuch as it is impossible to cone wheels to adapt themselves to all degrees of curvature. Again, in pulling a heavy loaded freight train around the same curvature at a speed from say eight to fifteen miles per hour, the flanges would, generally speaking, run towards the inner or lower rail which, of course, would

not be desirable or advantageous. Another point is, with coned wheels the tendency is for them to bear exclusively on the inner side of the rail, with an outward pressure corresponding with weight of load, which causes a great wear of rail and adds to the loosening of the spikes, thereby increasing the danger of track spreading and causing derailment, whereas with straight tread the bearing is on the surface of the rail, equally distributed, which lessens the outward pressure, thereby reducing the danger of the tracks spreading. The bearings of the straight tread wheel being equally distributed on tread, lessens the wear in throat of flange, which is the weakest part of wheel. Therefore, I claim inasmuch as a wheel cannot be coned to adapt itself to all degrees of curvature to prevent slipping, no material advantage is gained, as with straight tread wheels we lessen the wear of wheel, rail and bearing, and reduce the liability of derailment.

6. As we reduce the wear of wheel we get a corresponding increase of mileage.

7. I enclose blue print of tread of wheel (see plates 53 and 54. We have no straight tread wheels worn out, so cannot comply with your request to send drawings of same.

Yours very truly,

G. W. PRESCOTT,

Supt. M. P. and Machinery, Texas & St. Louis R. R.

FARNHAM, QUEBEC, May 29, 1884.

F. G. Brownell, Chairman, etc.:

DEAR SIR:—I am sorry to be so late in writing to you, but have been absent a greater part of the time since I saw you. In reply to the questions, I have to say:

1. Almost wholly.
2. Some tires straight two inches and tapered on the edge.
3. Use one twelfth and recommend the same.
5. Yes, slightly.
6. No record.
7. Will try and have some data at Long Branch.

My opinion on the subject at issue is simply this: our wheels should all be coned and all the same taper to the foot on account of getting a uniform bearing on the rail. Probably the greatest argu-

ment in favor of coned wheels is the fact that we seldom get wheels of exactly the same diameter, and instead of running the flange of small wheel hard against the rail and making sharp flanges, as would be the case if tread was straight and wheels of unequal diameter, they find by lateral motion the point of equal diameter and retain that position on the rail. While I do not lay any great stress on the matter of cars having coned wheels curving more easily, as the rigid wheel base does now allow the axles to have a position that would give a perfect result of the conical theory, yet I believe they do curve slightly easier and that parties who have roads with a succession of curves are generally of this opinion. I also notice we are not able to maintain any but a conical shape on treads which have been turned straight. This may be attributed to the fact that a large majority of our wheels are coned, but in my opinion it would be much more difficult to maintain a straight than a coned tread, even if all wheels were made or turned straight, as we have a round corner at flange that is inclined to throw the bearing away from itself and consequently keep a larger diameter than the main bearing on the rail.

Referring to the circular, I taper my wheels one-eighth inch in three inches on tread, or one-twelfth inch to the inch in diameter, and believe this to be a good shape. Yours truly,

A. G. EASTMAN,
Mech. Supt. Southeastern R. R.

SOUTH AUSTRALIAN RAILWAYS,
LOCOMOTIVE ENGINEER'S OFFICE,
ADELAIDE, May 16, 1884.

T. G. Brownell, Esq., Master Mechanic, Burlington & Lamoille Railway, Burlington, Vermont, U. S.:

SIR,—I regret your enclosed notice did not reach me until a few days ago, thus making it impossible for me to send in replies by date requested. I beg to furnish answers as under to the questions asked:

1. Yes; almost in every case, the only exceptions being a few flangeless wheels which are always made parallel, because the positions which flangeless wheels often run in, when going round

curves, in relation to the rails is the opposite of the positions of flanged wheels. We use flangeless wheels for six or eight-wheeled coupled engines, and for the centre pairs of six-wheeled tenders and carriages—English types.

2. Only when positioned with flanged wheels, as above described.

3. The angle of cone is 1 in 26, irrespective of diameter of wheel.

4. We cone the outer edge as per tracing (see plate 55) enclosed, in order to secure gradual and smooth contact with points and crossings.

5. Yes.

6. Have not carried out any experiments for this purpose.

7. The enclosed tracings (see plate 58) illustrate our standard tire sections of crucible cast steel for flangeless and flanged tires respectively when new. Tracing (see plate 56) also shows the gauge we use to ascertain when the tires are sufficiently worn down to condemn. When the point *f* of this gauge touches the edge *Z* of the tire it shows the minimum thickness has been reached. A similar gauge is used for carriage and wagon tires, but it allows them to be worn down ⅛ inch thinner than engine tires. The gauge shown on tracing (see plate 57) is applied to flanges when worn away by running round curves. When the flange allows it to slip over as shown the wheels are stopped and sent to the workshops for re-turning of tires. I have the honor to be, sir,

Your obedient servant,

WILLIAM THOW.

BURLINGTON, VT., June 2, 1884.

To the Members of the American Railway Master Mechanics' Association:

DEAR SIR,—I take pleasure in communicating to you the results of my personal experience with straight and cone tread wheels.

The road bed under my charge has very many sharp curves and very high grades.

In 1877 our company put on the road two engines, standard gauge, Farlee or Bogie truck, each with six-wheeled truck under tender, and one with four and the other with six drivers. When we

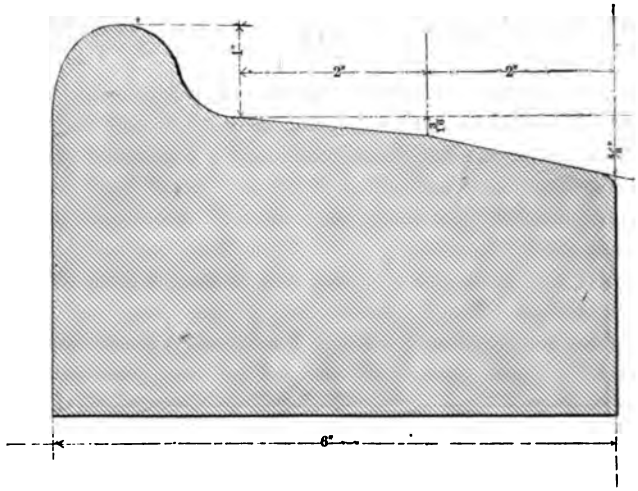


Plate 52.

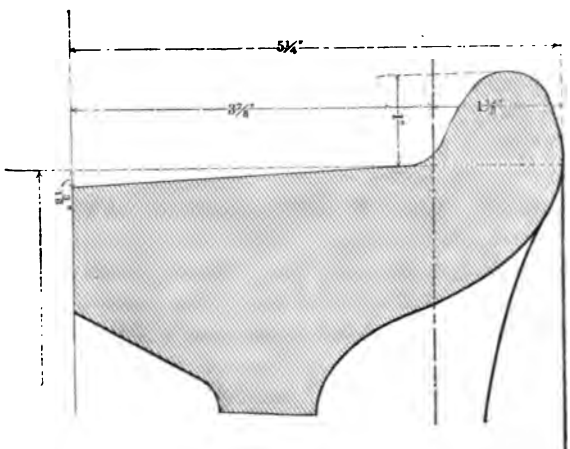


Plate 53.

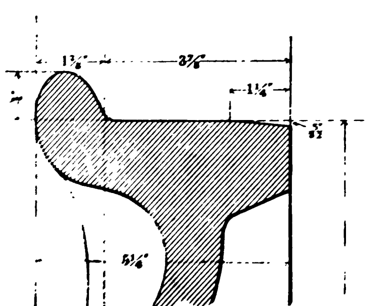


Plate 54.

received them their tires were turned nearly straight. We found that within a year the flanges on the forward drivers were worn so sharp that the engine had to be hauled off. I tried the experiments of putting a sponge saturated with oil in contact with the forward driver and of running a small pipe from tank so as to keep the tread constantly moist, but without realizing satisfactory results. I then concluded to cone the tread of the wheels, and had the tires turned three-eighths of an inch smaller on the outer edge than they were at the base of the flange. Good results were immediately apparent, and the engines run between three and four years before it was necessary to turn them again. Besides, we found that the engines curved with the track without climbing, a difficulty we had experienced when the tread was straight. The six-wheel engine I took and turned her tires one-half inch smaller on the outer edge than they were at the base, with equally beneficial results. Finding that on this road the coning of the wheels operated so beneficially I tried the experiment on an eight-wheeled American passenger engine with equally good results. With this latter engine I discovered that one effect of the coning of the wheels was to do away with a swaying oscillating motion, with which we had been troubled. This suggested that possibly a wheel for passenger cars adapted to the peculiar curves and gradients of our road could be made which would do away with the oscillating motion of the cars as well as protect the flanges, and with the help of the accomplished manager of the road, Hon. D. C. Linsley, we made a pattern for passenger car wheels (blue print, plate 59, is a copy of the original drawing), and so far we have had very good success, the coning of the wheels having obviated the difficulties which we had before experienced.

Before closing this report I wish to take this opportunity to return my sincere thanks to the different master mechanics and super intendents of motive power, who have so kindly responded to the circular, and I sincerely hope that the result of their labors will be the advancement of economy and safety in the operation of railways.

Yours respectfully,

F. G. BROWNELL, Chairman,
M. M. B. & L. R. R.

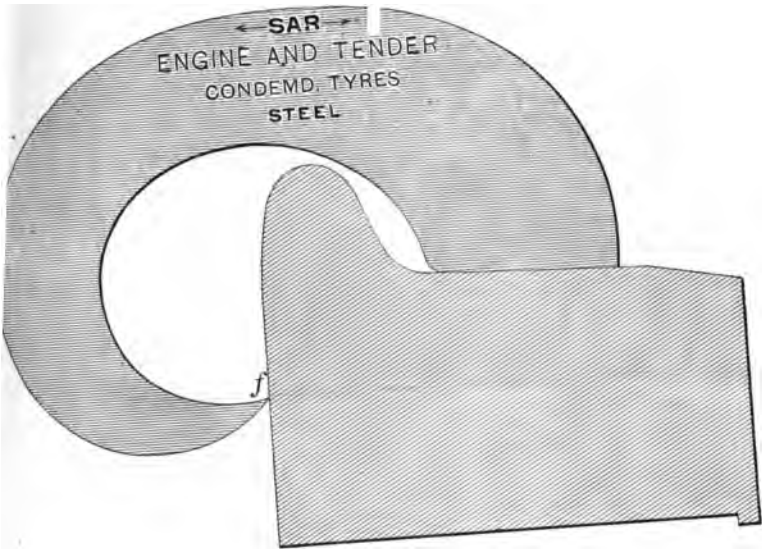


Plate 56.

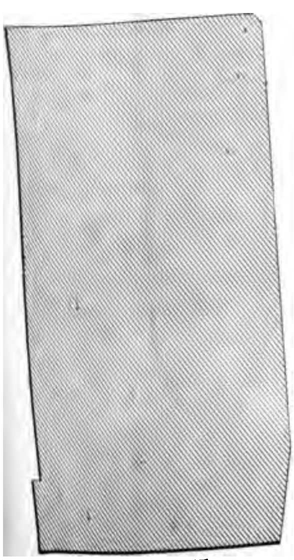
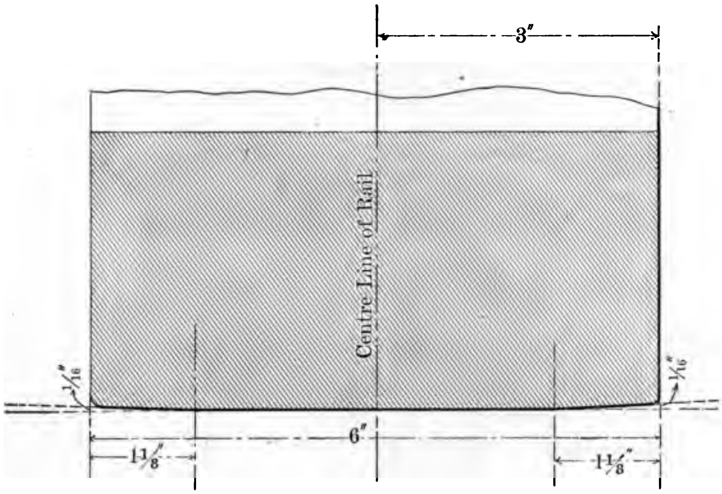


Plate 55.

Plate 57.


3″
Centre Line of Rail
1/16″
1/16″
6″
1 1/8″
1 1/8″

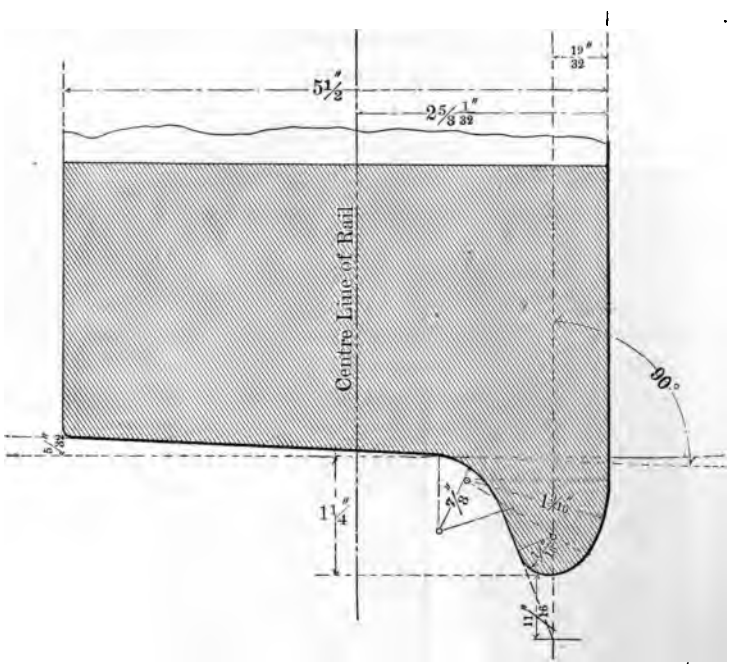

19/32″
5 1/2″
2 5/8 1/32″
Centre Line of Rail
90°
1 1/4″
1 1/16″
11/16″

Plate 58.

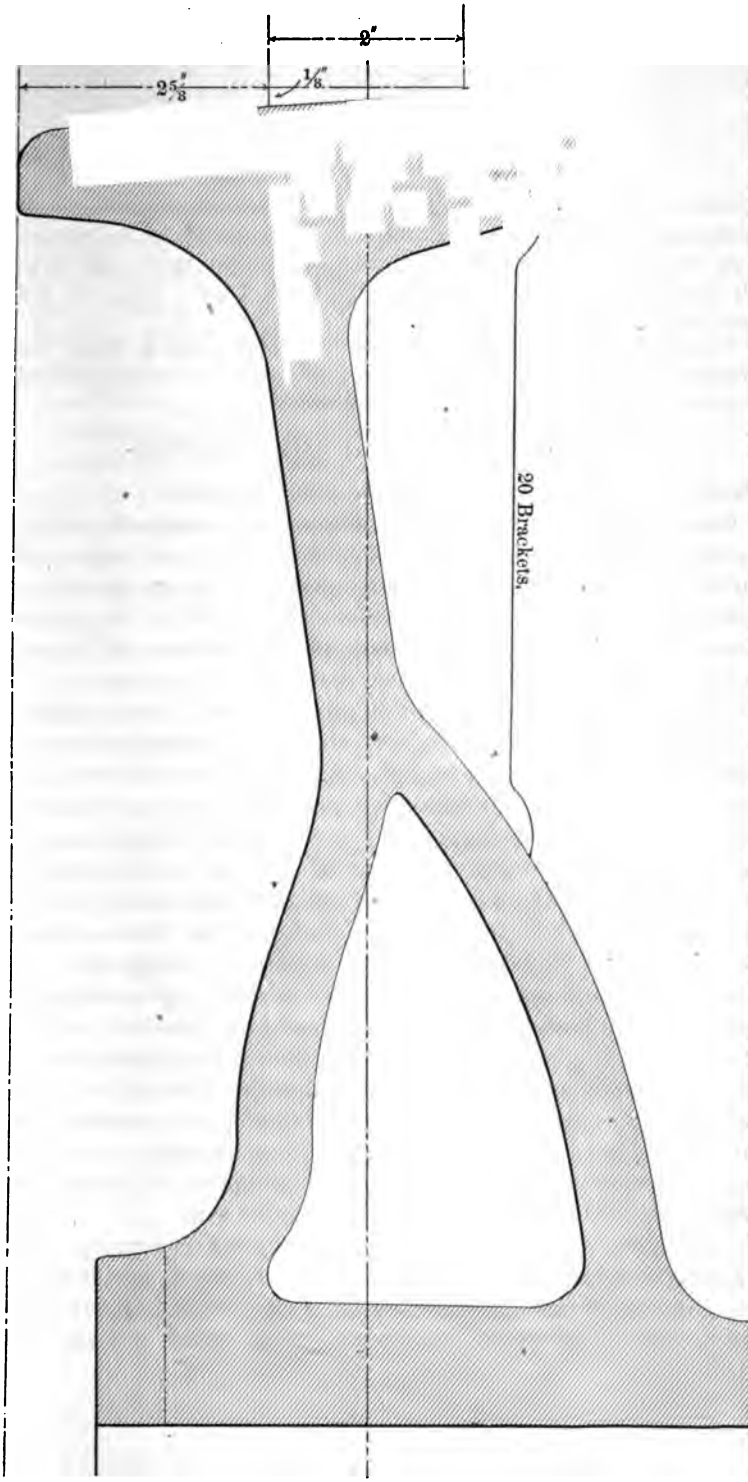


Plate 59.

THE PRESIDENT—The next business is "Associate members to read papers at the next meeting." believe there are one or two papers from associate members in the hands of the Secretary—one from Mr. Angus Sinclair, and one from Mr. F. W. Dean. They are not very lengthy, and the Secretary will read them.

I will state for the information of the Convention that it is only ten minutes past eleven, and we have considerable time yet, and I think we can get through without hurrying very much.

FUEL ECONOMY WITH LOCOMOTIVES.

To the American Railway Master Mechanics' Association:

GENTLEMEN,—During the last twenty years remarkable reduction has been made in the cost of moving railroad trains, and an important portion of the saving effected in transportation expenses is due to the labors of this Association. While there is just ground for pride over past achievements, the work must still go on, for great progress must yet be made in the line of economy.

We have heard much said of late about the keen, close competition which our food producers are going to encounter in the near future from the breadstuffs raised by the cheap labor of Russia and India. A factor in this problem, perhaps more important than the original cost of production, is the cost of handling and transportation to market. The vital struggle in this race will probably be decided by taxing the ability of our railroads to make still greater reductions in the cost of moving the produce of our Western farms to the seaboard. As the locomotive department nearly always receives the first attention when a demand for reducing operating expenses arises, I shall endeavor to suggest how important savings might be effected without impairing the efficiency of the service.

Although the American locomotive compares favorably with the average stationary or marine engine in the economical application of power, there is still room for improvement, as can be proven by a comparison with the work done by locomotives in Europe of similar dimensions to ours, while doing similar work.

During the month of March, last, the engines running the Chicago Limited Express on the Pennsylvania Railroad, between Jersey City and Philadelphia, burned 63.35 pounds of coal per train mile. Some engines on other roads doing similar service, and

burning bituminous coal, show a slightly better duty; but the Pennsylvania locomotive may be accepted as a fair average of American locomotive practice, with two or three notable exceptions. On a good representative road in this country a Mogul engine with cylinders 18x24, pulling twenty-five loaded cars, on an average, burns 120 pounds of coal per mile. This may be considered among us, fair economical work for a freight engine.

The famous Webb compound locomotive, on the London and North-western Railway, has been running a train of about the same weight and speed as the Pennsylvania Railroad's Chicago Limited Express over a road quite as hard to operate, with a fuel expenditure under 30 pounds to the mile. This engine may be regarded as having exceptional means for steam saving, but the best engineering authorities in England contend that its performance is no better than that of many good locomotives that are not compounded. The "Gladstone," a well-known engine belonging to the London, Brighton and South Coast Railway, having cylinders 18½x26, burns 31 pounds of coal to the mile, while running an express train weighing about 200 tons at a speed of 45 miles an hour. From the record of work done by engines on the Great Northern Railway, I find that a freight engine, with cylinders 18x26, pulling a train similar to that handled by the Mogul already referred to, and over a road whose physical features are nearly the same, does its work with a fuel consumption of 50 pounds to the mile. Many attempts have been made to explain away the unfavorable fuel record our engines make compared with those in Europe of the same size doing similar work, but these well-meaning attempts have not been convincing. If other engines are making a better record than ours, our best way toward equaling or excelling them is to recognize the truth and investigate the cause. Considerable experience with the running of locomotives on both sides of the Atlantic, leads me to believe the allegation that greater expense is incurred in operating our locomotives than what is found necessary with British engines to be genuine and founded on undeniable data. I shall endeavor to point out some of the causes which I think contribute to this undesirable condition of affairs.

Proper investigation would probably identify several causes as contributing to the unfavorable record of the American locomotive. However good an engine may be, it is not likely to make an economical showing unless the men in charge are interested in bringing about this result. The American locomotive engineer and fireman are second to none following the same calling for intelligence and high character, but they are not trained up in the rigid ideas of fuel economy that prevails among the enginemen of Britain. There are roads here where strict economy is habitually practiced, but they are exceptional. The average fireman on the ordinary run of roads gives no heed to coal-saving, his work being regarded as good so long as he keeps up the required head of steam. Before firemen can be blamed for this laxity, an examination of the means at their command to promote fuel-saving is necessary. An important item of heat waste is the steam thrown away through the safety valve. Now, what aid has the fireman received from the locomotive builders and designers in restraining this source of waste? The ordinary ash-pan is made without pretense of being air-tight, and to call its doors dampers is a delusion and a snare. There is also a greater evil in this than the mere loss of heat by steam blowing off. Firemen are prevented from learning the practice of regulating the admission of air to suit the fire, so they fall into the habit of making the fire suit the full admission of air.

Let us suppose that every pound of coal consumed in the fire-box is capable of generating 14,500 units of heat, combustion being effected by the oxygen taken from twelve pounds of air. In this case there would be thirteen pounds of mixed gases heated by the heat liberated from the single pound of coal, elevating the temperature to 4,700 degrees Fahr. But locomotive fire-boxes, when the engine is working, need a liberal supply of air to effect complete combustion, and 18 pounds of air to the pound of coal is low for the intense draft of our engines. To heat up nineteen pounds of gas, one pound of coal will not raise the temperature higher than 3,200 degrees Fahr.—a loss of 1,500 degrees below the other, and every additional pound of superfluous air cools the gases of combustion in like proportion.

My object in adverting to this well-known fact is, to allude to its practical effect on our loose methods of controlling air admission. When an engine is working with a heavy fire, more air is needed to penetrate the mass and effect combustion than what is necessary where a light fire is carried. But our practice is to give the same supply for both cases. The consequence is that an engine will not steam with a light fire, because the rush of air is so great through the thin coating of coal that the gases are chilled below the point of ignition. In approaching stations or long descending grades, firemen could often let the fire go light if they could regulate the admission of air by proper dampers as their compeers on British engines are enabled to do. This practice of permitting a free rush of air through locomotive grates at all times is responsible for more waste of fuel and damage to fire-box sheets than is generally recognized.

What appears to be another source of loss with us is the practice of using viciously contracted exhaust nozzles. When we reflect that induction of furnace draft by exhaust steam, is subject to the same laws that regulate the induction of a current of water by the steam jet of an injector, it seems a curious spectacle to see the exhaust steam passed from the pipes through two parallel nozzles, neither of which can be central to the lift-pipe or stack that the steam must use as an induction pipe. This I conceive to be a violation of the laws controlling induced currents, and its bad effects have to be remedied by resorting to means which entail other disturbing agencies. Any one who has tried to make an injector work when the internal tubes were out of line, knows that he had a difficult job to accomplish. An engine with double nozzles is in the same position in regard to draft induction as the injector is in regard to its ability to throw water when the tubes are out of line. The exhaust steam does not go straight up the stack, acting like a piston to form a clean vacuum behind. Its tendency is to strike on the sides of the stack or pipe, breaking its unity, reducing its velocity, and leaving fragments of the volume behind. To overcome this obstacle to free induction, increased speed of exhaust steam is resorted to, which is obtained by contracting the nozzles This increased speed of exhaust steam is rendered necessary to prevent

the scattering steam from destroying the vacuum in the smoke-box. This is not a mere hypothesis. It is the teaching of observation and experiment with engines at work.

The single nozzle is almost universally used in Europe. An ordinary engine with cylinders 17x24 inches will steam freely with nozzles 5 inches diameter, giving an opening of 19.6 square inches. On the Elevated Railroads of New York, single nozzles are employed, and their standard engine with cylinders 11x16 inches steam freely with a nozzle 3 inches diameter, or 7 square inches area of opening. That cylinder has a cubical capacity of 1,520 inches. Where double nozzles are used their diameter for a cylinder 17x24 inches is about 3 inches. A cylinder of this size has a cubical capacity of 5,424 inches. So the steam from this large cylinder has to escape through an opening as small as that which induces draft to make steam from a cylinder less than one-half its capacity. The result of this system is that the ordinary locomotive suffers chronically from back pressure in the cylinders due to unduly contracted exhaust orifices.

It may be said that a certain height of smoke-box vacuum must be secured to make an engine steam, no matter what kind of nozzles are employed. But facts do not substantiate that theory. Every one who has tried the two forms of nozzles knows that steam can be made freely with a much lower vacuum when a single nozzle is employed than in the case of double nozzles. And where a decrease of smoke-box vacuum is practicable a direct saving of fuel is effected through the fire not being torn up so much by the blast. This also permits a steadier fire-box temperature since the current of surplus air is less fluctuating.

The only advantage claimed for the practice of using double nozzles, is that a single opening allows the exhaust steam from one cylinder to shoot over through the junction of the exhaust pipes into the other cylinder, causing more back pressure than contracted nozzles. This defect is due to a wrong pattern of exhaust pipe. Where the pipes are designed so that the steam is flowing in a nearly vertical direction before the junction of the pipes is reached, there is no trouble from it passing over into the other exhaust pipe. Indicator cards taken from the engines on the Ele-

vated Railroads show no shooting over of the steam, and British locomotives indicate no loss from this source.

The practice very general in Europe of using driving wheels much larger than ours may have some influence on economy of heat. An engine running at a rate of 45 miles an hour, having drivers 66 inches diameter, exhausts 15 times each second; an engine with drivers 84 inches diameter, running at equal speed, exhausts 12 times each second. The effect which the rapid exhausts have upon the fire appears to have received too little attention. When the period between the exhausts is long enough to admit the gases to flow with a pulsating motion, their speed through the flues must decrease between the exhausts. This would permit more of the heat to be abstracted for evaporation. Those who are in the habit of running engines up steep grades with heavy trains, know that so soon as the engine begins to move slow the generation of steam becomes exceedingly rapid, although the engine may be working up to its highest capacity. Heavy work done under such circumstances is performed very economically, which n ay be due to the slow exhaust permitting effectual absorption of thc heat.

While I stand second to none in admiration of the many excellent qualities of the American locomotive, I think there is a possibility of making it lighter on fuel. In working toward that end the points brought up in this paper may be found worthy of investigation.

ANGUS SINCLAIR.

THE PRESIDENT—You have heard the paper by Angus Sinclair read. What do you wish to do with it?

MR. SPRAGUE—I move that it be received.

Carried.

THE PRESIDENT—Our next business is the reading of a paper by Mr. F. W. Dean, on "coupling rods for passenger locomotives."

THE THEORY OF THE STRESSES IN LOCOMOTIVE COUPLING RODS.

Gentlemen of the American Railway Master Mechanics' Association:

A year ago I had the honor of reading before you a paper entitled "Improvements in Locomotives," and in that paper I touched upon the subject of coupling rods for passenger locomotives. I take the liberty of returning to this portion of the subject at the present time on account of the appearance in several technical journals of an article giving very fully an erroneous theory of the stresses in these rods. The theory referred to (and which in this paper will be called the erroneous theory) in fact makes the stress only 50 per cent. (see Note 1 at the end of this paper) of the proper amount. This being so, evidently its use would greatly endanger life and property, and its refutation is therefore important. Moreover, it appears to me eminently appropriate to discuss the theory before the association most concerned in such matters.

As a preliminary to the discussion, it is important to say that throughout this paper the locomotive is assumed to have attained a uniform speed.

The erroneous theory treats the subject from the standpoint that the coupling rod has a uniformly increasing vertical velocity from zero to a maximum and then to zero again, or in other words, that it has a constant acceleration and retardation. If, however, we reflect that the changes in vertical velocity are identical with those which would exist if the engine were not moving as a whole but whose wheels were revolving uniformly, it will be seen that the accelerations are not constant. For this reason the theory is incorrect, and the use of the formula $V = \sqrt{2gh}$ (which is based upon the conception of constant acceleration) is irrelevant. Moreover, this theory would have the rod most and equally in stress when at its mid-vertical and highest and lowest positions (because at each of these points it would, by the erroneous theory, meet with the same changes from retardation to acceleration and *vice versa*) and least and equally in stress at all other positions, which is absurd. As will presently appear, the stress is a maximum when the rod is in its highest and lowest positions and a minimum when in its mid-positions.

It is now necessary to seek a correct theory.

Through space, each point of a locomotive coupling rod describes a curve known to mathematicians as a *trochoid.* This is a curve generated by a point whose motion is composed of a uniform circular motion and a uniform rectilinear motion. Each of these components can be treated independently in such a problem as this, (*vide* Rankin, Weisbach, Collignon, etc.,) for we must bear in mind that we are investigating stresses produced solely by motion. Such stresses can only be produced by inertia. The force of inertia can only be made manifest by a change in direction of motion, or by a change in velocity. Our rectilinear motion is perfectly uniform; it can therefore produce no force of inertia, and consequently can be entirely neglected. It is therefore evident that we have only to consider the circular component of the motion. This brings us at once to the conclusion that it is proper to suppose the locomotive blocked up and turning its wheels at any desirable uni form rate, and to compute the stress on this supposition.

Hence each point of a locomotive coupling rod describes a circle about some centre, and develops, in virtue of inertia, the force known as centrifugal force, the value of which is $C=\frac{Wv^2}{gR}$, in which

W=the weight (say in pounds),
v=circular velocity in feet per second,
g=32.2=the acceleration of gravity in feet per second,
R=the radius of the crank in feet.

This force acts *along* the rod when in its mid-vertical position, and at *right angles* to it when at its lowest and highest positions. If it were not for the weight of the rod the latter two cases would be identical, but it is evident that when the rod is highest the weight is subtracted from the centrifugal force, and that when it is lowest the weight is added to the force. The last is the maximum of all cases, and should be considered.

Finally the rod is a beam supported at both ends and loaded uniformly (as all the circles previously mentioned have equal radii) with the centrifugal force and its own weight.

Applying this theory to the solid rectangular rod assumed in the article under criticism, we have the following data:

No. of revolutions per minute	247
Radius of crank in feet	1
Resulting velocity of each point of the rod	25.8 ft.
Length of rod between pin centres, inches	108
Depth " in inches	$3\frac{1}{2}$
Thickness of rod in inches	$1\frac{3}{4}$
Weight " per lineal inch, in pounds	1.71
Total weight of rod between pin centres, lbs.	185

Substituting these numbers in the formula for centrifugal force, we have

$$C = \frac{1.71 \text{x} 670.8}{32.2 \text{x} 1} = 35.6 \text{ lbs.}$$

for each inch of length. For the whole length the centrifugal force is 35.6x108=3,845 lbs. Adding to this the weight of the rod, we have 3,845+185=4,030 lbs. as the total transverse load to be supported. Placing this number in the usual formula for beams, the greatest stress per square inch is

$$f = \frac{3\,Wl}{4bd^2} = \frac{3 \times 4030 \times 108}{4 \times 1.75 \times 3.5^2} = 15,235$$

The erroneous method gave 8,120 lbs. If we add the stress due to the cylinder pressure the result is about 17,235 lbs., which is too great for practice. This is in accordance with our sense of the fitness of sizes, for I believe that no master mechanic would consider it prudent to use a coupling rod on a locomotive 9 feet by $3\frac{1}{2}$ inches by $1\frac{3}{4}$ inches. As a matter of fact the stress would exceed 17,235 lbs. per square inch, for the load would deflect the rod one-third of an inch, and the cylinder pressure would act with this lever arm, tending to bend it still more. Of course there are various other accidental causes of stress.

The *I* form of rod described in the article under criticism weighs the same as the other, but is 6 inches deep, has flanges $2\frac{1}{2}$ inches wide by $\frac{3}{4}$ inches thick, and a web $\frac{1}{2}$ inch thick. Making the computation for this, the resulting stress is 5,380+2,000=7,380 lbs. per square inch. This is a good working rate, but none too small for such service. Comparing this with the stress of the solid

rod, the benefit of channeling is very strikingly shown. The channeled rod deflects only one-tenth inch.

In conclusion I wish to say that I have prepared the two following formulas for practical use in computing stresses on coupling rods, which I can confidently recommend.

(1.) For rods with a rectangular cross-section:

$$f=\frac{\frac{3}{4}W(1+.0003406Rn^2)l+.7854pD^2d}{b\ d^2}$$

in which

f=greatest stress in pounds per square inch,
W=weight of rod between pin centre, in pounds.
R=radius of crank in feet.
n=number of revolutions per minute.
l=length of rod between pin centres in inches.
b=thickness of rod in inches.
d=depth " "
D=diameter of cylinder in inches.
p=boiler pressure in pounds per square inch.

(2.) For *I* section rods:

$$f=\frac{\frac{3}{4}W}{d}\times\frac{(1+.0003406Rn^2)l}{a^1+6a}+\frac{.7854pD^2}{a^1+2a}$$

in which

f=greatest stress in pounds per square inch.
R=radius of crank in feet.
n=number revolutions per minute.
l=length of rod between pin centres, in inches.
d=depth of *web*, in inches.
a=area of cross-section of either flange in square inches.
a^1= " " " " *web*, " "
D=diameter of cylinders, in inches.
p=boiler pressure in pounds, per square inch.

The first term of the second member of each formula has reference to the weight and centrifugal force of the rod, and the last to the piston pressure. F. W. DEAN.

PHILADELPHIA, June 2, 1884.

NOTE 1.—Proof that a body of mass M having an acceleration p from velocity o to velocity v in the space R during the time t, generates a force one-half in amount that of the centrifugal force of the same body, moving with a velocity v in a circle of radius R.

$$R=\frac{pt^2}{2} \therefore p=\frac{2R}{t^2}$$

hence the force generated in the first case is

$$F=Mp=M\frac{2R}{t^2} \quad (1)$$

The centrifugal force in the second case is

$$F.=\frac{Mv^2}{R}$$

but

$$v=pt, \text{ and } R=\frac{pt^2}{2}$$

$$\therefore p=\frac{2R}{t^2}$$

$$\therefore v=\frac{2Rt}{t^2}=\frac{2R}{t}$$

$$\therefore v^2=\frac{4R^2}{t^2}$$

$$\therefore F.=M\frac{4R^2}{Rt^2}=M\frac{4R}{t^2} \quad (2)$$

which is twice (1). Q. E. D.

THE PRESIDENT—You have heard the paper read by Mr. Dean. How will you dispose of it?

MR. LAUDER—I move that the paper be received and incorporated in our annual report.

The motion being duly seconded, was put and carried.

THE PRESIDENT—This completes the papers. If there is any other business that the members have to offer in the matter of reports, or anything to be adopted, we can hear it before we proceed further. The next business in the order of our calendar will be the election of officers but previous to that, *if* there is anything to present, we will hear it.

MR. LAUDER—I would call for the report of the Auditing Committee. The Chairman is present.

THE PRESIDENT—Is the Auditing Committee ready with their report.

THE CHAIRMAN—(Reading.) Your committee beg leave to report that they have examined the accounts of the Secretary and Treasurer, and find them correct.

Moved and seconded that the report be accepted.

Carried.

MR. LAUDER—I have a couple of resolutions that I would like to have acted upon now, if it would be the proper time. The first is that we are adding to our membership from year to year in numbers, many of whom, of course, have been with us in years gone by, and who thoroughly understand the matters referred to by each member, but there has been some action that should be understood by other members of the Association. I have reference more particularly to standards adopted by this Association. We once adopted a standard size for driving wheels, and I presume there are very few of us that know what these standards are, and perhaps few of us are following them, and I think it would be well to adopt a resolution like this. It won't give the Secretary much labor, I think, to include it in his report:

Resolved: That the standards up to the present time adopted by the Master Mechanics' Association be printed in the Annual Report.

It will entail some labor on the Secretary, but we pay him for his services, and I think it would be valuable especially to our new members to know just when and what standards we have adopted.

Carried.

MR. LAUDER—There is one more resolution that I would like to present. Perhaps it needs a little explanation. Part of the members are probably familiar with the subject, but I presume part of them are not. I think that the Seller's system of threads has been adopted by this Association as a standard, and many of us, I presume, find great difficulty in this respect, that round iron is not of uniform size. It is generally a little over size, consequently we have to get the iron cut down beyond what it would take to make a full thread, the result of cutting the iron down being to tear the thread off when the dies are not in perfect order, or ruining the dies where we have to cut it down a thirty-second to one-sixteenth more than we ought to, in order to get it down to our standard size. Now, the Master Car Builders' Association took this matter up, and adopted a certain system, which I think is a good one. I have adopted it, and have procured the gauges. They have adopted a set of gauges made by Pratt & Whitney, to which all round iron shall be sub-

jected before it is accepted from the dealer. It has a table made of steel, stamped in a very systematic, thorough and workmanlike manner. Also a test gauge goes with it. One end is 100th, or about 100th part of an inch smaller than the other. Now, the idea is that the round iron shall be between these two limits. We can not say to dealers that they shall make three quarter round iron exactly three quarters. It would not be practicable; but we can say it shall not be over three-quarters and 100th of an inch from size, neither 100th of an inch less than three-quarters. Probably most of you are familiar with this matter, in connection with the Car Builders' Association.

A few of us in Boston, Mass., have got our gauges, and notified our dealers that all round iron sent to us will be subjected to this limit gauge, and after this explanation I would offer this resolution for the consideration of the Association:

Resolved: That the following sizes for gauges for round iron for Seller's standard threads are hereby established by the Master Mechanics' Association as the standard size for such gauges, and that it is recommended that all round iron of nominal standard size be made of such diameter that each one will enter the large or plus end of the gauge intended for it, and will not enter the small end; that is to say, all iron must be so that the big end will go on, and it must not be small enough to allow the small end to go on. I think it should be passed, and then all railroads that choose to get the gauges can do it, and know that they are getting something that is uniform, and by and by dealers will understand that all roads are going to submit their goods to these tests, and will act accordingly, and then you will get rid of these troubles, and the nuisance of having iron rolled over size.

Motion carried.

THE PRESIDENT—I would remind the members that the Committee on Assessment are here, and they request me to give notice that they are ready to receive dues at any time that members see proper to wait on them.

Our next business will be the election of officers for the ensuing year.

THE SECRETARY—I will read the report of the Nominating Committee. Your committee will suggest the following names of officers:

For President—J. H. Flynn.

First Vice-President—J. D. Barnett.

Second Vice-President—William Woodcock.

Treasurer—George Richards.

Secretary—J. H. Setchel.

For one member of the Standing Committee for Subjects—T. B. Twombly, Chicago.

Signed by

J. N. Lauder,
John Devine,
Allen Cook,
Committee.

The President—You have heard the report of the committee. What disposition will you make of it?

It is moved and seconded that the report be received, and the candidates balloted for. Ballots prepared for President.

Mr. Lauder—Before the election for President commences I would like to say a word, why the committee this year have made a departure, and made positive recommendations, and have only recommended one name for each position. I don't know how that may strike the Convention, but, of course, they all understand that these recommendations are simply recommendations, and that they don't bind any member of the Association to vote for or against any one they may wish. I would like to read a letter I have received, that would perhaps be interesting in several ways:

To J. N. Lauder, Chairman:

Dear Sir:—While there is nothing in the by-laws to prevent the election of the same person as President of this Association for a second, or any number of terms, if the members see fit to do so, but as I believe that two terms in succession is as many as it is desirable to elect any person, and that we ought to establish the principle of rotation in office, as regards the presidency, and feeling that some might not understand my views on this question, I desire to say to you as Chairman of the Committee, that while I well appreciate the compliments paid me, and am very thankful, I will not, under any consideration, be a candidate for re-election to the office of President for another term.

Yours truly,

R. Wells.

I read that because you will remember I took strong ground in favor of the rotation in office as far as President was concerned, and lots of our new members may not have understood the thing as my friend Wells and I understand it. I think that we should every two years bring in a little new blood.

THE PRESIDENT—I will appoint as tellers Mr. Swanston and Mr. Fuller, if they will please come forward. Our constitution requires that we vote by ballot, and that it is necessary that the person chosen receive a majority of all votes cast.

A ballot was then taken for President for the ensuing term, the candidates being John H. Flynn and William Woodcock.

Fifty-two votes were cast, of which 50 were in favor of John H. Flynn and 2 for William Woodcock.

Mr. John H. Flynn was declared duly elected President.

The ballots were then prepared for the election of First Vice-President, the only candidate being J. D. Barnett.

Forty-five votes, the whole number cast, were recorded in favor of the candidate, who, on motion, was declared duly elected.

A ballot was then taken for Second Vice-President for the ensuing term, the only candidate being William Woodcock, who received 39 votes, and was declared duly elected.

A ballot was then taken for the election of Treasurer for the ensuing term, George Richards being the candidate:

Mr. Richards received 38 votes, and was declared duly elected.

A ballot was then taken for the election of a Secretary for the ensuing term. John H. Setchel and E. M. Roberts were the candidates.

Forty-five votes were polled for J. H. Setchel and one for E. M. Roberts.

Mr. J. H. Setchel was declared duly elected.

A ballot was then proposed to be taken for the election of a committee of three members to propose subjects for discussion and investigation, the election to be for three years, one member retiring each year.

Moved and seconded that Mr. T. B. Twombly be elected a member of the Committee on Subjects for three years by a rising vote.

Carried unanimously.

The Secretary then read the report of the Committee appointed to select a place of meeting for the Eighteenth Annual Convention, as follows:

To the American Railway Master Mechanics' Association:

GENTLEMEN:—Your Committee for the selection of a place for our next Annual Meeting offer the following names: Niagara Falls, Cincinnati, and Montreal.

Signed: JOHN H. FLYNN,
GEORGE HACKNEY,
A. G. EASTMAN.

MR LAUDER—I suggest Washington as a more appropriate place than either of the places named.

No objection being made to the addition of Washington to the list, it was included accordingly.

A ballot was then taken, and votes were cast as follows:

In favor of Washington as the place of meeting, 45; Cincinnati, 5; Niagara Falls, 1; Montreal, 3.

MR. JOHANN—I move that the salary of our Secretary be fixed the same as last year.

THE PRESIDENT—Is the appropriation for this or the past year, Mr. Secretary?

THE SECRETARY—For the past year.

MR. JOHANN—That the compensation of Secretary be fixed at $600.

MR. LAUDER—I desire to make an amendment by substituting $800; $600 is not enough. The business of the Association has increased so much that the compensation of the Secretary should also be increased. We have now 33 per cent. more members than 5 years ago.

MR. JOHANN—I will accept Mr. Lauder's amendment.

Carried unanimously.

THE PRESIDENT—The report of Committee of Subjects for discussion at our next Convention recommends that the following subjects be investigated:

1. Improvement in boiler construction.
2. New plans for constructions and improvements in locomotives.
3. Improvementss in valve gear.
4. Steel castings for locomotives.
5. Best metal for locomotive bearings.
6. Driving wheel brakes. To what extent is their use advisable?
7. Is the frequent testing of boilers by hydraulic pressure advisable?
8. Smoke stacks and spark arresters.
9. Shop tools and machinery.

Signed, GEORGE RICHARDS,
JOHN H. FLYNN,
Committee.

Motion made for acceptance of report and duly seconded.

Carried.

THE PRESIDENT—The names of the gentlemen to investigate these subjects will be furnished within the next two or three months by the Secretary. The appointment will be made by our new President. This has been our custom for several years past. The members appointed will receive notices of their appointment within the next 6 weeks or two months.

MR. JOHANN—The Executive Officers should not wait two months before doing this. Let it be done early, and let the committee go to work and get the information.

MR. FLYNN—The officers will take the remarks into consideration, and will endeavor to get the committee appointed as early as possible.

MR. SPRAGUE—The members of the Association should make a point of answering one circular thoroughly, and give the committee a full investigation on some one subject, and as much as they can on the others. We want information to make a report out of.

MR. SETCHEL—There is a little matter that I would like to bring up at this time, if in order! We have on our list of honorary members the names of three men that we delight to honor—Isaac Dripps, who was with us yesterday, a former Vice-President, W. A. Robinson, Hamilton, Canada, and J. L. White, probably, next to Mr. Dripps, one of the oldest master mechanics in the United States, and I desire to place in nomination for the position of honorary members our former President, H. M. Britton, who, I think, for 8 years was President of this Association, and Charles R. Peddle, an old master mechanic who has now retired from active life in that position, and I move that they be made honorary members, and added to our list.

The motion, being duly seconded, was put to the meeting, and carried.

THE SECRETARY—The Committee on Resolutions beg leave to report the following:

That the thanks of this Association are due, and are hereby tendered to the Rev. F. T. Brown, the Rev. E. D. Tompkins, the Committee of Entertainments, J. E. Wootten, General Manager of the Philadelphia and Reading Railroad, the proprietors of Leland's Ocean Hotel, the Executive Committee, the ladies present, and the members of the press, for their favors and attention, which greatly contributed to the success of the meeting and the enjoyment of the members; and also to Mr. Charles T. Parry, for his kind entertainment invitation to the Association to visit Beach Haven.

Signed: F. P. MILES, WILLARD A. SMITH, ANGUS SINCLAIR,
Commi tee.

Moved and seconded that this report be received.

Same carried unanimously.

Mr. Brownell presented the following resolution:

Resolved, That the thanks of this Association be tendered to the retiring President, Mr. Reuben Wells, for the able and practicable manner

in which he has conducted the affairs of this Association for the past two years.

MR. LAUDER—I would move the adoption of that resolution.

MR. SPRAGUE—I second the motion.

The members voted by rising from their seats.

Carried unanimously.

MR. BARNETT—Mr. President, I have very much pleasure in returning thanks to you for the manner in which you have presided over this Convention and the affairs of the Association for the period during which you have occupied the chair.

THE PRESIDENT—*Gentlemen of the Association:* I believe that I am thankful for the favors that you have conferred on me. I have endeavored at all times to discharge the duties of the office to my best ability. I know very well that the business has not been discharged as well as it ought to have been, but it has been as well as I could do it under the circumstances, and as I retire from the Presidency of this Association I shall always continue to retain as great an interest in the welfare of this Association as I have in the past, and I can assure you that so far as my assistance or my efforts can avail anything, I shall do everything for the prosperity of this Association in the future.

As there does not appear to be any more business before the meeting, a motion to adjourn will be in order.

On motion the Convention adjourned to meet on the third Tuesday in June, 1885, at Washington, D. C.

COMMITTEES AND SUBJECTS FOR DISCUSSION AT THE EIGHTEENTH ANNUAL CONVENTION.

Improvement in Boiler Construction.

J. JOHANN, W. & St. L. R. R.,
J. DAVIS BARNETT, M. R. R.,
ALLEN COOK, C. & E. I. R. R.

New Plans for Construction and Improvement in Locomotives.

W. WOODCOCK, C. of N. J. R. R.,
G. W. STEVENS, L. S. & M. S. R. R.,
A. W. SULLIVAN, I. C. R. R.

Improvement in Valve Gear.

CHAS. BLACKWELL, N. W. & S. V. R. R.,
J. F. DEVINE, W. & W. R. R.,
M. M. PENDLETON, S. & R.

Best Metal for Locomotive Bearings.

JAMES M. BOON, N. Y. W. S. & B. R. R.,
J. S. GRAHAM, L. S. & M. S.,
J. P. HOVEY, R. & P. R. R.

Steel Castings and Locomotives.

R. W. BUSHNELL, B. C. R. & N. R. R.,
JNO. BLACK, C. H. & D. R. R.,
T. J. HATSWELL, F. & P. M. R. R.

Driving Wheel Brakes. To What Extent is Their Use Advisable?

C. BERKLEY POWELL, O. C. R. R.,
J. F. CROCKETT, B. L. & N. R. R.

Is the Frequent Testing of Boilers by Hydraulic Pressure Advisable?

H. N. SPRAGUE, H. K. Porter & Co.,
W. L. HOFFECKER, O. & M. R. R.,
D. O. SHAVER, P. R. R.

Smoke Stacks and Spark Arresters.

W. F. TURREFF, C. C. C. & I. R. R.,
J. B. ROSS, N. Y. L. E. & W. R. R.,
W. T. SMITH, K. C. R. R.

Shop Tools and Machinery.

JNO. HEWITT, Mo. P. R. R.,
HOWARD SMITH, St. L. B. & T. Co.,
O. A. HAYNES, St. L. I. M. & S. R. R.

Associate Members to Read Papers at the Eighteenth Annual Meeting.

WILLARD A. SMITH, Chicago Review.
F. B. MILES, of Philadelphia.

Committee of Arrangements for Eighteenth Annual Meeting.

E. H WILLIAMS,
S. A. HODGMAN,
T. L. CHAPMAN.

CONSTITUTION.

As Amended at the Fourteenth Annual Meeting, Providence, June 14, 1881.

PREAMBLE.

We, the undersigned Railway Master Mechanics, believe that the interests of the Companies by whom we are employed, may be advanced by the organization of an association which shall enable us to exchange information upon the many important questions connected with our business. To this end do we establish the following

CONSTITUTION.

ARTICLE I.

SECTION 1. The name and style of this Association shall be the AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

ARTICLE II.

SEC. 1. The officers of the Association shall be a President, a First and Second Vice-President, a Secretary, and a Treasurer.

SEC. 2. The above-named officers shall be elected separately, by ballot, at each Annual Convention, and a majority of all votes cast shall be necessary to a choice.

SEC. 3. Two Tellers shall be appointed by the President to conduct the election and report the result.

ARTICLE III.

SEC. 1. It shall be the duty of the President to preside in the usual manner at all the meetings of the Association, and approve all bills against the Association for payment by the Treasurer.

SEC. 2. It shall be the duty of the Vice-Presidents, according to rank, to perform the duties of the President in his absence from the meetings of the Association.

SEC. 3. In case of the absence of both President and Vice-Presidents the members present shall elect a President *pro tempore.*

SEC. 4. It shall be the duty of the Secretary to keep a full and correct record of all transactions at the meetings of the Association; to keep a record of the names and places of residence of all members of the Association, and the name of the road they each represent; to receive and keep an account of all money paid to the Association, and at the close of each meeting deliver the same to the Treasurer, taking his receipt for the amount; to receive from the Treasurer all paid bills, giving him a receipted statement of the same.

SEC. 5. It shall be the duty of the Treasurer to receive all money from the Secretary belonging to the Assciation to receive all bills against the Association, and pay the same, after having the approval of the President; to deliver all paid bills to the Secretary at the close of each meeting, taking a receipted statement of the same: to keep an accurate book account of all transactions pertaining to his office.

ARTICLE IV.

SEC. 1. The following persons may become members of the Association by signing the Constitution, or authorizing the President or Secretary of the Association to sign for them, and pay the initiation fee of one dollar. Any person having charge of the mechanical department of a Railway known as "Superintendents," or "Master Mechanics" or "General Foremen," the names of the latter being presented by their superior officers for membership, also two Mechanical Engineers, or the representative of each Locomotive Establishment in America.

SEC. 2. Civil and Mechanical Engineers, and others whose qualifications and experience might be valuable to the Association, may become Associate Members by being recommended by three Active Members. Their names shall then be referred to a committee, which shall report to the Association on their fitness for such membership. Applicants to be elected by ballot at any regular meeting of the Association, and five dissenting votes shall reject. The number of Associate Members shall not exceed twenty. Associate Members shall be entitled to all the privileges of active members excepting that of voting.

SEC. 3. Any person who has been or may be duly qualified, and signs, or causes to be signed, the Constitution, as member of the Association, remains as such until his resignation may be voluntarily tendered.

SEC. 4. All members of the Association will be liable for such dues as may be necessary to assess to defray the expenses of the Association, and any member who shall be two years in arrears for annual dues

shall have his name stricken from the roll, and be duly notified of the same by the Secretary.

ARTICLE V.

SEC. 1. The regular meeting of the Association shall be held annually on the third Tuesday in June.

SEC. 2. Regular meetings shall be held at such place as may be determined upon by a majority of the members present at the previous meeting.

SEC. 3. An adjourned meeting may be held at any time and place that a majority of the members present at any meeting may elect.

SEC. 4. The regular hours of session shall be from 9 o'clock A. M. to 2 o'clock P. M.

SEC. 5. During the business sessions no communications shall be received or acted upon other than those pertaining to the business of the Association.

SEC. 6. At this, the Thirteenth Annual Meeting, the President shall appoint three members to constitute a standing committee to recommed of the Association at each Annual Meeting subjects for discussion at each succeeding Convention, one member for three years, one for two years, and one for one year, designating the term of each member, and each succeeding year one member of said committee shall be elected by the Association by ballot.

The said committee shall, at one o'clock on the second day of each Annual Convention, report to the Association subjects for discussion at the succeeding Convention.

At 7:30 o'clock of the second day of each Annual Convention there shall be a joint meeting of said Committee with an advisory committee, composed of the officers of the association, which joint committee shall, at [illegible] o'clock on the morning of the third day of each Annual Convention, nominate to the Association the members of the several committees upon said subjects. Said joint committee shall nominate, upon subjects which require reports, from various parts of the country, full committees of three or five, which committees shall be called committees of research, and shall have power to solicit reports from not all but a part of the members of the Association upon such subjects; and upon other subjects said joint committee shall nominate simply the chairman of the committees, who shall have power to select their own associates upon such committees, which shall be called committees of investigation; said joint committee shall also nominate two Associate Members to read papers at the succeeding Annual Meeting.

All committees so appointed, whether of research or investigation,

shall meet at four o'clock on the afternoon of the third day of each Annual Convention to plan and divide its work for the ensuing year.

Each committee on research shall, on or before the first day of July of each year, send to the Secretary of the Association a circular letter setting forth the character of reports desired from the members, together with a list of persons to whom said letter shall be sent; and the Secretary shall immediately print and mail the same to such members, with an earnest request that, as a matter of courtesy, full replies thereto shall be sent on or before the first day of April following to the chairman of such committees.

Each committee, whether of research or of investigation, shall, if possible, meet pursuant to the call of its chairman, during the second week in April of each year, for the preparation of its report, which, in the absence of such meeting, shall be prepared by the chairman, and shall immediately forward the same to the Secretary of the Association, by whom it shall be printed and supplied to the members at the commencement of each Annual Convention.

Each report of such committees shall name the members of the Association from whom replies to said circular letters were requested but not received, on or before the first of April as aforesaid.

ARTICLE VI.

SEC. 1. This Constitution may be amended at any regular meeting of the Association by two-thirds vote of the members present.

Resolution Passed at the Sixth Annual Meeting, Baltimore, Maryland, May, 1873.

Resolved, That no expense shall be incurred by committees except by the unanimous consent of the General Supervisory Committee, given in writing to the Chairman of said Committee, stating the amount to be expended.

Resolution on Boston Fund, Passed at the Eighth Annual Meeting, New York, May, 1875.

Resolved, That the Boston Fund, amounting now, with accrued interest, to $3,620, be invested in Government securities to be selected by the duly appointed Trustees, and not to be disturbed for the purpose

of expenditure unless authorized by the majority of members present in open Convention, and then only after due notice of a motion to expend the same has been given at the session immediately preceding; and that the interest accumulating shall every year be invested in the same manner as the principal, and a full account of the same be duly reported with other financial statements.

Resolution Adopted at the Ninth Annual Meeting.

***Resolved*, That members of the Association who have been in good standing for a period of not less than five years and who through age or other cause cease to be actively engaged in the mechanical departments of railroad service, may, upon the unanimous vote of the Association, be elected "Honorary Members," who shall have their dues remitted and be entitled to all the privileges of regular members except that of voting.**

ORDER OF BUSINESS.

1. Reading the Minutes of the previous meeting.
2. Calling the Roll of Members.
3. Signing the Constitution.
4. Report of Secretary.
5. Report of Treasurer.
6. Report of Committees appointed at a previous meeting.
7. Election of Officers.
8. Appointment of a Committee to suggest Subjects for Consideration.
9. Appointment of Miscellaneous Committees; Finance, Printing, and Place of Holding Next Annual Meeting.
10. Report of Committee to suggest Subjects for Consideration.
11. Appointment of Committees to report upon Subjects suggested for Consideration.
12. Unfinished Business.

JOHN H. FLYNN,
J. DAVIS BARNETT,
WM. WOODCOCK,
GEORGE RICHARDS,
J. H. SETCHEL,
Committee.

NAMES AND ADDRESS OF MEMBERS.

NAME.	ROAD.	ADDRESS.
Anderson, H.,	204 Dearborn Street,	Chicago, Ill.
Anderson, J. H.,	N. Y. B. & P.,	Providence, R. I.
Anderson, E. D.,	Illinois Central	Macomb City, Miss.
Barton, J. C.,	H. & C. W.,	Hartford, Conn.
Bryan, H. S.,	C. & I.,	Aurora, Ill.
Boon, J. M.,	N. Y. W. S. & B.,	Franklin, N. Y.
Bushnell, R. W.,	B. C. R. & N.,	Cedar Rapids, Ia.
Brastow, L. C.,	C. R. R. of N. J.,	Wilkesbarre, Pa.
Boyden, G. E.,	N. Y. & N. E.,	Boston, Mass.
Brooks, H. G.,	Brooks Locomotive W'ks,	Dunkirk, N. Y.
Barnett, J. Davis,	Midland,	Port Hope, Ontario.
Black, John,	C. H. & D.,	Lima, O
Blackwell, R. C.,	D. & H. C. Co.,	Albany, N. Y.
Bissett, John,	C. & E.,	Florence, S. C.
Briggs, R. H.	C. O. & S. W.,	Elizabethtown Ky.
Bradley, S. D.,	G. R. & I.,	Grand Rapids, Mich.
Brigham, L. L.,	Passumpsic,	Lyndonville, Vt.
Brownell, F. G.,	P. & S.,	Burlington Vt.
Berry, L. D.,	D. M. O. & S.,	Osceola, Iowa.
Brokaw, W. I.,	L. R. M. R. & T.,	Arkansas City, Ark.
Bothwell, James,	C. & N. W.,	Baraboo, Wis.
Brooks, L. R.,	Lima Iron Works,	Birmingham, Ala.
Blackwell, Charles,	N. & W.,	Roanoke, Va.
Bosworth, B. C.,	C. V.,	Canton, Ohio.
Cullen, James,	N. & C.,	Nashville, Tenn.
Campbell, E. A.,	N. Y. T. & M.,	Victoria, Texas.
Campbell, John,	L. V.,	Delano, Pa.
Colby, G. H.,	B. & A.,	Boston, Mass.
Cascaddin, R. O.,	C. R. I. & P.,	Trenton, Mo.
Chapman, N. E.,	Midvale Steel Co., 333 Walnut St.,	Philadelphia, Pa.
Chapman, J. W.,	N. Y. L. E. & W.,	Hornellsville, N. Y.
Chapman, Thos. L.,	C. & O.,	Richmond, Va.
Cummings, S. M.,		Boston, Mass.
Coolidge, Geo. A.,		Charlestown, Mass.

NAME.	ROAD.	ADDRESS.
Clark, David,	L. V.,	Hazleton, Pa.
Clark, Peter,	Northern,	Toronto, Canada.
Cooper, H. L.,	L. E. & W.,	Lafayette, Ind.
Cook, James,	Danforth & Cook's L. W.,	Paterson, N. J.
Cushing, George,	N. P.,	St. Paul, Minn.
Crockett, John F.,	B. L. & N.	Boston, Mass.
Colburn, Richard,		Norwich, Conn.
Clifford, J. G.,	L. & N.,	Bowling Green, Ky.
Cook, John S.,	Georgia,	Augusta, Ga.
Cook, Allen,	C. & E. I.,	Danville, Ill.
Dotterer, S. H.,	D. & H. C. Co.,	Carbondale, Pa.
Donaldson, Arthur,		Vincennes, Ind.
Davis, N. L.,	R. & V.,	Rutland, Vt.
Devine, J. F.,	W. & W.,	Wilmington, N. C.
Dripps, W. A.,	3224 Walnut Street,	Philadelphia, Pa.
Durgin, J. A.,	34 Pine Street,	New York.
Domville, C. K.,	G. W. of Canada,	Hamilton, Canada.
Downe, George,	Government R. R.,	Sidney, Australia.
Evans, Edward,	C. W. & B.,	Chillicothe, Ohio.
Ellis, Matthew,	C. St. P. M. & O.,	St. Paul, Minn.
Eddy, H. W.,	B. & A.,	Springfield, Mass.
Eblen, James,	L. R. & Ft. S.	Argenta, Ark.
Ellis, J. C.,	Schenectady Loco. W'ks,	Shenectady, N. Y.
Ellis, W. H.,	P. & R.,	Catawissa, Pa.
Eckford, James,	N. Y. C. & St. L.,	Bellevue, Ohio.
Eastman, A. G.,	S. E.,	Richford, Vt.
Ennis, W. C.,	N. Y. S. & W.,	Wortendyke, N. J.
Foss, J. M.,	C. V.,	St. Albans, Vt.
Fuller, William,	N. Y. P. & O.,	Cleveland, O.
Finlay, L.,		L ttle Rock, Ark.
Foster, W. A.,	W. & M. Div. F. R. R.,	Fitchburg, Mass.
Fowle, I. W.,	V. & M. and N. O. & N. E.,	Meridian, Miss.
Ferguson, G. A.,	B. C. & M.,	Lake Village, N. H.
Flynn, J. H.,	W. & A.,	Atlanta, Ga.
Griffith, T. B.,	D. L. & W.,	East Buffalo, N. Y.
Greenwood, A. W.,	E. B. T.,	Orbisonia, Pa.

NAME.	ROAD.	ADDRESS.
Gates, G. W.,	Western of N. C.,	Salisbury, N. C.
Garrett, H. D.,	Pennsylvania,	Philadelphia, Pa.
Griggs, Albert,	P. & W.,	Providence, R. I.
Gordon, H. D.,	P. W. & B.,	Wilmington, Del.
Graham, Charles,	L. & B.,	Kingston, Pa.
Gilson, Gregg D.,	Hemmingway & Brown,	75 State St., Boston, Mass.
Gordon, James T.,	Concord R. R.,	Concord, N. H.
Graham, J. S.,	L. S. & M. S.,	Buffalo, N. Y.
Gilmore, W. L.,	C. C. C. & I.,	Cleveland, O.
George, Nathan M.,	D. & W.,	Danbury, Conn.
Hinman, M. L.,	Brooks Locomotive W'ks	Dunkirk, N. Y.
Headden, John,	Rogers Locomotive W'ks	Paterson, N. J.
Harding, B. R.,	R. & G.,	Raleigh, N. C.
Hollister, James D.,		Savannah, Ga.
Ham, C, T.,	Buffalo Steam Gauge Co.,	Rochester, N. Y.
Hewitt, John,	M. P.,	St. Louis, Mo.
Hall, Sen. Don Diago,	Sup't. Loco. Dep't, F. C.,	Santiago, Chili, S. A.
Haynes, O. A.,	St. L. I. M. & So.,	St. Louis, Mo.
Hodgman, S. A.,		Wilmington, Del.
Haggett, J. C.,	D. A. V. & P.	Dunkirk, N. Y.
Hanson, C. F.,	G. W. of Canada	London, Ontario.
Hackney George,	A. T. & S. F.,	Topeka, Kansas.
Hackney, C.,	A. T. & S. F.,	Topeka, Kansas.
Howison, N. W.,	C. & R.,	Mt. Savage, Md.
Henny, John J.,	N. Y. N. H. & H.,	Hartford, Conn.
Henny, J. B.	Hartford Steam Co.	Hartford, Conn.
Howe, Geo. E.,	St. J. & L. C.,	St. Johnsbury, Vt.
Hatswell, T. J.,	F. & P. M.,	East Saginaw, Mich.
Hovey, J. P.,		Rochester, N. Y.
Horniblower, J. P.,	Government R. R.	Queensland, Austral
Hull, J. W.,	L. & N.,	Montgomery, Ala.
Hicky, John,	M. L. S. & W.,	Manitowoc, Wis.
Hoffecker, W. L.,	O. & M.,	Vincennes, Ind.
Inness, Thomas B.,	115 Broadway	New York City.
Ivanson John,		Cincinnati, O.
Johnson, J. B.,	N. C.,	Helena, Ark.

NAME.	ROAD.	ADDRESS.
Johann, Jacob,	W. & St. L.,	Springfield, Ill.
Jeffery, E. T.,	Illinois Central,	Chicago, Ill.
Jacques, Richard,	Hemmingway & Brown,	75 State, St., Boston.
Kielmer, John T.,	812 East York Street,	Philadelphia, Pa.
Kinsey, J. I.,	L. V.,	Easton, Pa.
Keeler, Sanford,	F. & P. M.,	East Saginaw, Mich.
Lithego, Joseph,		Providence, R. I.
Leeds, Pulaski,	L. & N.,	Louisville, Ky.
Losey, Jacob,	Steam Forge Co.,	Louisville, Ky.
Lauder, J. N.,	Old Colony,	Boston, Mass.
Leech, H. L.,	No. 1 Rollins Street,	Boston, Mass.
Lannon, William,	House of Representatives,	Washington, D. C.
Lewis, W. H.,	D. L. & W.,	Kingsland, N. J.
Levis, J. M.,	S. M. & M.,	Marion, Ala.
Lape, John R.,	T. P.,	Big Springs, Tex.
Lowe, George W.,	C. & N. W.,	Clinton, Iowa.
Mast, F. M.,	L. E. & St. L.,	Evansville, Ind.
Millholland, Jas. A.,	G. C. & C.,	Cumberland, Md.
Maynes, W. C.,	C. & E. I.,	Chicago, Ill.
Meehan, James,	C. N. O. & T. P.,	Ludlow, Ky.
McGrayel, John M.,	D. M. & F. D.,	Grand Junction, Iowa.
Middleton, Harvey,	St. P. M. & N.,	St. Paul, Minn.
McCune, J. C.,	Sonora,	Guy Mass, Mexico.
Mulligan, J.,	Conn. River,	Springfield, Mass.
Mitchell, A.,	L. V.,	Wilkesbarre, Pa.
Morse, G. F.,	Portland Loco. Works,	Portland, Maine.
McGlenn, James.	Carolina Central,	Laurinburg, N. C.
McKenna, J.,	I. P. & C.,	Peru, Ind.
McCrum, J. S.,	M. R. Ft. S. & G.,	Kansas City, Mo.
McVay, John		Chattanooga, Tenn.
Morrell, J. E.,	C. R. I. & P.,	Davenport, Iowa.
Miller, W. H.,	Transfer & Stock Yard Co.,	Indianapolis, Ind.
Minshall, E.,	N. Y. O. & W.,	Middleton, N. Y.
McFarland, W.,	St. P. & D.,	St. Paul, Minn.
Montgomery, Wm.,	N. J. Southern,	Manchester, N. J.
Noble, L. C.,	H. & T. C.,	Houston, Texas.

NAME.	ROAD.	ADDRESS.
Olcott, H. P.,	A. T. & S. F.	Deming, New Mexico.
Ortton, John,	N. Y. C.,	East Albany, N. Y.
Paxson, L. B.,	Philadelphia & Reading,	Reading, Pa.
Petrie, Ira,	J. & S. E.	Jacksonville, Ill.
Pringle, R. M.,	St. L. & C.,	St. Louis, Mo.
Pendleton, M. M.,	S. & R.,	Portsmouth, Va.
Perry, F. A.,	C. & A.,	Keene, N. H.
Perrin, P. J.,	Taunton Loco. Works.	Taunton, Mass.
Prescott, G. W.,	T. & St. L.,	25 S. 4th st., St. Louis.
Philbrick, J. W.,		Waterville, Maine.
Prescott, G. H.,	T. H. & I.,	Terre Haute, Ind.
Purves, T. B.,	B. & A.,	East Albany, N. Y.
Place, T. W.,	I. C.,	Waterloo, Iowa.
Porter, J. S.,	I. B. & W.,	Sandusky, Ohio.
Patterson, J. S.,	C. I. St. L. & C.,	Cincinnati, Ohio.
Parry, C. T.,	Baldwin Loco. Works	Philadelphia, Pa.
Player, John,	Central of Iowa,	Marshalltown, Iowa.
Powell, C. Berkeley,	Old Colony,	Boston, Mass.
Pillsbury, Amos,	Eastern,	Boston, Mass.
Richardson, E.,	S. V.	Greenville, Pa.
Ranson, Thos. W.,	I. & St. L.,	Mattoon, Ill.
Richards, Geo.,	B. & P.,	Boston, Mass.
Robb, W. D.,	L. & N.,	Pensacola, Fla.
Reynolds, G. W.,		Taunton, Mass.
Ross, Geo. B.,	N. Y. L. E. & W.,	Buffalo, N. Y.
Renshaw, W.,	I. C.,	Chicago, Ill.
Roberts, E. M.,	Ashland Coal & Mining Co.,	Ashland, Ky.
Rennell, Thos.,	M. & L.,	Argenta, Ark.
Richardson, R. M.,	St. L. & I. M.,	Little Rock, Ark.
Stone, W. A.,	N. Y. & N. E.,	Norwich, Conn.
Sanborn, C. A.,	T. H. & I.	East St. Louis, Mo
Stokes, J. W.,	O. & M.,	Pana, Ill.
Sullivan, A. W.,	I. C.,	Chicago, Ill.
Smith, Howard M.,	St. L. B. & T. Co.,	St. Louis, Mo.
Sanborn, J. M.,	L. S. & M. S.,	Norwalk, Ohio.
Scruten, C. E.,	E. & W. of Ala.,	Cedartown, Ga.
Sellers, Morris,	No. 6, Ashland Block,	Chicago, Ill.

NAME.	ROAD.	ADDRESS.
Schlacks, Henry,	Ill. Cent.,	Chicago, Ill.
Smith, W. T.,	K. C.,	Covington, Ky.
Smith, Allison D.,	Government R. R.,	New Zealand.
Strode, James	N. C.,	Elmira, N. Y.
Stearns, W. H.,	Conn. River,	Springfield, Mass.
Shaver, D. O.,	Pennsylvania R. R.,	Pittsburgh, Pa.
Setchel, J. H.,	O. & M.,	Cincinnati, O.
Sanborn, A. J.,	Ohio Southern,	Springfield, Ohio.
Smith, Wm.,	Boston & Maine,	Boston, Mass.
Stevens, G. W.,	L. S. & M. S.,	Cleveland, Ohio.
Selby, W. H.,	W. & St. L.,	Moberly, Mo.
Sedgley, James,		Cleveland, O.
Simmonds, G. B.,		Sedalia, Mo.
Sitton, B. J.,	S. R. & D.,	Selma, Ala.
Swanston, Wm.,	J. M. & I.,	Indianapolis, Ind.
Steel, W. J.,		Nashville, Tenn.
Short, Wm. A.,	Wisconsin Central,	Stevens Pt., Wis.
Smith, Wm. F.,		Carlin, Nevada.
Tandy, H.,	Canada Loco. Works,	Kingston, Ont.
Twombly, F. M.,	Old Colony	Taunton, Mass.
Twombly, T. B.,	C. R. I. & P.,	Chicago, Ill.
Turreff, W. F.,	C. C. C. & I.,	Cleveland, O.
Tewon, H. A.,		Brainerd, Minn.
Taylor, J. K.,	Boston & Lowell,	Boston, Mass.
Thumser, John,		Seymour, Ind.
Thaw, Wm.,	S. A.,	Adelaide, Australia.
Tregelles, Henry,	N. Y. L. E. & W.,	Salamanca, N. Y.
Teal, S. A.,	S. C. & P.,	Missouri Valley, Iowa.
Thomas, W. H.,	C. & O.,	Huntington, W. Va.
Thompson, John,		Boston, Mass.
Thompson, W. A.,	M. H. & O.,	Marquette, Mich.
Underhill, A. B.,	B. & A.,	Springfield, Mass.
Ulmo, H. A.,	C. & S.,	Savannah, Ga.
Van Vechten, J.,	N. Y. L. E. & W.,	Susquehanna, Pa.
Wakefield, S. W.,	C. R. I. & Pac.,	Keokuk, Iowa.
Watrous, Geo. C.,	D. L. & N.,	Iona, Mich.

NAME.	ROAD.	ADDRESS.
West, Geo. W.,	S. C. & N. Y.,	Syracuse, N. Y.
Walsh, Thomas,	L. & N.,	Mt. Vernon, Ill.
Warren, W. B.,	I. B. & W.,	Indianapolis, Ind.
Wells, Reuben,	L. & N.,	Louisville, Ky.
Wiggins, J. E.,	S. P. & T. N.,	Marshall, Tex.
Woodcock, W.,	C. R. R. of N. J.,	Elizabethport, N. J.
Williams, E. H.,	Baldwin Loco. Works,	Philadelphia, Pa.
Weaver, D. L.,	C. O. & S. W.,	Elizabethtown, Ky.
White, Philip,		Wellsville, O.
Wilder, F. M.,	N. Y. L. E. & W.,	Susquehanna, Pa.
Wightman, D. A.,	Pittsburgh Loco. Works,	Pittsburgh, Pa.
White, C. W.,	L. & N.,	Birmingham, Ala.
White, J. F.,	I. C.,	Water Valley, Miss.
Watts, Amos,	T. P.,	Marshall, Tex.
Williams, C. G.,	C. R. R. of N. J.,	Communipaw, N. J.
Whitney, H. A.,	Intercolonial R. R.,	Moncton, N. B.

ASSOCIATE MEMBERS.

Dean, F. W.,		East Taunton, Mass.
Evans, W. W.,	Sans Souci, near New Rochelle, N. Y.	
Forney, M. N.,	73 Broadway,	New York City.
Gordon, Alex.,	Niles Tools Works,	Hamilton, O.
Hill, Jno. W.,		Cincinnati, O.
Lilly, J. O. D.,		Indianapolis, Ind.
Lyne, Lewis F.,	307 Grove Street,	Jersey City, N. J.
Miles, F. B.,		Philadelphia, Pa.
Morton, Henry,	Prof. Stevens Institute,	Hoboken, N. J.
Sellers, Coleman,		Philadelphia, Pa.
Smith, Willard A.,	Chicago Review,	Chicago, Ill.

NAME.	ROAD.	ADDRESS.
Sinclair, Angus,	American Machinist, 96 Fulton St.,	New York City.
Wheelock, Jerome,		Worcester, Mass.

HONORARY MEMBERS.

Britton, H. M.,	R. W. & O.,	Oswego, N. Y.
Drippes, Isaac,	3405 Walnut Street,	Philadelphia, Pa.
Peddle, C. R.,	T. H. & I.,	Terre Haute, Ind.
Robinson, W. A.,		Hamilton, Canada.
White, J. L.,		Danville, Ill.

OBITUARY.

MR. CHAS. A. SMITH

An associate member of this Association, and lately Professor of Civil and Mechanical Engineering at Washington University, St. Louis, Mo., died at Newburyport, Mass., on February 2nd, 1884, after a long and painful illness.

Mr. Smith was born in St. Louis, Mo., in 1846, but the death of his mother at an early age occasioned his removal to Newburyport, the native place of both his parents.

After passing through the public schools of that place he chose the profession of civil engineer, and proceeded to fit himself for it at the Boston Institute of Technology.

After graduating at this institution he worked on the Utah Division of the Union Pacific Railroad, in Echo Canyon, and in 1870 he received the appointment of Instructor in Engineering in Washington University, St. Louis, and shortly afterwards was promoted to the professorship of Civil and Mechanical Engineering.

In addition to his labors in the University he was for a time Consulting Engineer of the Iron Mountain Road. He built the St. Charles water works, was interested in steam heating and in many other works in Missouri and neighboring States.

He was an associate member of the American Association of Master Mechanics, a member of the American Society of Civil Engineers and was for many years Secretary of the Engineers' Club of St. Louis. He was especially interested in the advancement of the American locomotive practice and had made several valuable experiments on the W. St. L. & P. Railway, the results of which have been given to the Association.

At the time of his death he had just completed the writing of two books on "Steam Making or Boiler Practice," being a practical treatise on boilers and their use, which books will have especial

value, owing to his having been a well known authority on all subjects pertaining to steam.

Mr. Smith was a remarkably able, energetic and enthusiastic engineer, and within a period of fifteen years he condensed the work of a lifetime. With a keen faculty of observation, he had also the habit of acquiring all practical knowledge that came in his way; for instance: while surveying for a railroad he learned to run an engine on construction train; and he was continually testing materials, studying the strength of iron in the foundries and gaining such knowledge as enabled him to plan such works as the iron roof of the St. Louis Chamber of Commerce, which is one of his most important designs.

In his early days having been compelled to earn his own way, he was well fitted for giving advice to those under the same circumstances, and he had a peculiar faculty for rendering the right help at the right time, and many a young man learned to know him as a true friend in need.

By his decease the Association loses a true friend, the scientific world a useful member, and his bereaved family a devoted husband and kind father.

JACOB JOHANN,
JOHN HEWITT,
H. M. SMITH, } Committee.

JOHN McFARLAND.

Mr. McFarland died in Richmond, Va., on the 16th of July, 1883, aged 57 years, after a short but severe illness.

He was born in Glasgow, Scotland, in 1826, and came to this country with his parents in 1836, settling in Richmond, Va., making this city his home until his death.

After learning the machinist trade he became desirous of following the occupation of a locomotive engineer. Having succeeded in attaining that position, he served as such on several Southern roads. He took such an interest in his occupation that he soon attracted attention by his gentlemanly deportment and mechanical

skill, and in 1855, at the age of 29, was appointed Master Mechanic of the Richmond and Danville R. R., holding that position for nearly eighteen years.

He was then made Master of Transportation of the Richmond and York River R. R. for a short time and in 1875 went to the Chesapeake and Ohio as Master of Machinery, the title afterwards being changed to Superintendent of Motive Power. This position he held until his death.

Mr. McFarland had been in failing health for a couple of years prior to his death, but, having a strong constitution, many years of usefulness seemed to be before him. His last meeting with the M. M. and M. C. B. Association was at Chicago, in 1883, and on his return it was the general verdict of his friends and associates that his health was much benefited by the trip. The writer remembers hearing him say on his return that he felt better than he had for years. He little thought then that the end was so near.

His sister and her husband having both died, leaving a family of five children, three girls and two boys, with no one to care for them, threw the responsibility upon him. This duty he faithfully performed. Never having married, his sole aim seemed to be to educate and provide a comfortable home for the charge left to his care, ever watchful over their interests, kind and indulgent as a father could be and of a genial disposition, his death was to them a severe blow.

Mr. McFarland was held in high esteem by the officers of the Chesapeake and Ohio R. R., and his amiable and generous disposition endeared him to all his associates and claimed the respect and obedience of his subordinates. He was buried in Hollywood Cemetery, Richmond, Va.

T. L. CHAPMAN,
JAMES MEEHAN,
R. H. BRIGGS.
Committee.

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